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AN EXPERIMENTAL STUDY OF THE LOCAL EFFECTS OF PERITONEAL DRAINAGE[1]

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THERE is probably no detail in modern surgical pathology that deserves more thorough comprehension, but which is less definitely understood by the average teacher, practitioner, and student, than the nature of the reaction of the peritoneum to drainage; nor is there another that so often savors as strongly of pioneer mysticism, if expressed opinions, written or spoken, may be taken as criteria. This study, stimulated by the experimental observations here recorded, has been of such great interest and profit to the writer, that its publication was undertaken with the hope that it might be of some benefit to others. It is not presumed that the evidence here adduced should have any manifest effect upon the methods derived from practical surgical experience, but there may possibly result a more accurate understanding of both the possibilities and limitations of a most valuable procedure. An exact scientific, rather than an empirical, conception of any principle must lead to its more intelligent and efficacious application.

The subject-matter will be taken up in the following order:

I. History.
II. Reported Clinical Observations.
III. Reported Experimental Observations.
IV. Original Experiments.
V. Deductions.
VI. Practical Significance.
VII. Conclusions.
VIII. Bibliography.

I. HISTORY

A study of the history of surgical drainage with special reference to the peritoneum has, aside from its intrinsic interest, some importance in showing the development of modern theory and practice.

Earliest Peritoneal Drainage. — Hippocrates (1) first described drainage-tubes, or canulæ, in advocating their use in the treatment of pleural effusions (empyema), and it was probably from him that Celsus (2) received his inspiration to treat similarly abdominal ascites. Celsus's tubes were not cylindrical, but conical, with the distal end of the greater circumference to prevent slipping within the abdomen. They were constructed of lead and brass, and were provided with plugs to regulate the outflow, as it was recognized that more than one sitting might be required to remove the fluid. Galen (3) and Avicenna (4), in the second century, upheld this treatment for ascites, but it was not until the fourteenth century that the subject again received consideration, when Chau-

[1] The experimental work was done in the laboratories of Surgical Pathology of Johns Hopkins Hospital, Pathology of the University of Pennsylvania, and Anatomy of the University of Chicago.

liaco (5) rediscovered drainage-tubes for the same usage. In the sixteenth century, Paré (6) figured tubes of gold and silver provided with a collar flange, and Ryff (7) again described similar instruments in the seventeenth century. Heister (8) and Scultitus (9) were both possessed of flanged metal tubes in the eighteenth century; the former apparently also used wicks in conjunction with the tubes, which seems to have been the earliest application of capillary drainage. At the close of this century, drainage must have been widely known, as Bell (10) laments the too common "putting by of solid and hollow tents."

Additional Indications for Drainage. — During the first half of the nineteenth century but little if any attempt was made to treat other intra-abdominal conditions than ascites by means of drainage, and the introduction by Fleury and Malgaigne (11) of rubber tubes within the metal to decrease the rapidity of outflow from the canula seems to have been the only innovation in this particular. At the close of this period the influence of McDowell's ovariotomy began to be more strongly felt. Operators were opening the abdomen with less hesitancy, and seeking faithfully, if painfully, for methods to reduce their discouraging mortality. While, at first, unconsciously applying a principle that was later to be discovered and rediscovered under the name of drainage, McDowell and certain of the other early "ovariotomists" did bring the long pedicle ligatures out through the abdominal wound—a menace rather than a safeguard. Sims (12) attributes the first extraperitoneal treatment of the pedicle to Duffin, at about this time, and this, also, has been regarded as a method of drainage.

As practical experience increased, it slowly came to be noticed that most of the fatal cases after ovariotomy, and indeed some that eventually recovered, showed an excess of serosanguinous fluid within the abdomen, which was prone to collect in the pelvis, particularly in the cul-de-sac. It was at first to the mere presence of this "secretion," and finally to its decomposition, that the fatalities were attributed. Septicemia from the absorption of this fluid came to be considered the common cause, as peritonitis was regarded as the exceptional cause of death (1:10, Sims). Keith well expressed the sentiment of the period in referring to "the red serum, that enemy of the ovariotomist," so generally was this view accepted. In the light of the times, it was therefore evident that this secretion must be removed or prevented, and that by either secondary (curative) or primary (prophylactic) drainage. Thus arose the question of the ways and means of abdominal drainage and the indications for its application. As it is probably only in the presence of ascites that continued peritoneal drainage is possible, it is easy to see how naturally the first workers in this field fell into error, and how well they were justified by a faulty theory yet to be practically disproven.

Rise and Fall of Secondary Drainage.—The first attempt to remove post-operative collections of fluid from the cul-de-sac through the vagina was made by Peaslee (13) in 1854, in flushing the pelvis through the vaginal vault with plain water, and later with a weak solution of chlorinated lime. Thus was established the first peritoneal lavage and medication. Lande (14) attributes to him the first drainage of the peritoneum through the vagina, though this must have been done unwittingly, as Peaslee himself credits this to Keith in 1864, to whom Lande also gives the doubtful distinction of originating peritoneal drainage through the rectum. Wegner (15) in 1866 referred to drainage through the vagina as Sims's greatest contribution. At any rate, the introduction of soft rubber tubes into surgery by Chassaignac (16) in 1859 was a most important factor in the more general adoption of this procedure, and to each of these men, and also to Wells, is due the credit for popularizing a therapeutic innovation that, for the time at least, was of great importance.

Material and experience accumulated very slowly, but finally it was quite generally recognized that the expected was not happening and that the results of secondary drainage were far from being satisfactory. The secretions did not always or completely gravitate into the cul-de-sac, and even when this occurred, the tubes often failed to accomplish their removal, and were prone to become kinked, compressed, or the fenestra plugged with fibrin. Secondary drainage thus came more and more into disfavor, while at the same time there developed

an increasing inclination towards the phrophylactic. Just as vaginal drainage had been stimulated by Chassaignac's introduction of rubber tubes, now was primary abdominal drainage developed by Koeberlé's use of glass tubes for this purpose in 1867, soon after followed by Keith and Wells. Koeberlé's tubes were shaped like a tenpin, with the base closed and provided with lateral apertures small enough (1 mm. in diameter) to prevent herniæ of omentum or intestine. Keith's and Wells's tubes were cylindrical, open at both ends, and also had lateral apertures.

The Popularity of Primary Drainage and its Decline. — Sims's influence, which was largely instrumental in causing the adoption of that theory of fatal septicemia arising from the absorption of the dreaded peritoneal secretion, became ascendent about 1870. He employed primary drainage in his ovariotomy, but still used the rubber tube, which was introduced through the vagina and brought out in the abdominal incision. He (12) also tried a hard rubber tube, shaped like cock's spur, but with such an unfortunate result that it was discarded and a speculum-like, self-retaining silver tube devised, which, however, was probably never used.

Sims's reported clinical and post-mortem observations of the malignant blood-stained serum, confirmed by others and by his Sedan experiences (18), turned the tide strongly in favor of prophylactic methods. It must be understood that there also was conservatism shown in both teaching and practice, notably by Gross, whose attitude won him the enmity of many of the enthusiasts. However, primary drainage became the fad. It was accepted enthusiastically by the German school, and by none more heartily, perhaps, than by Olshausen. Gradually, however, it, too, was found to accomplish less than was anticipated. The tubes did not always functionate satisfactorily. It was frequently noted that the lateral apertures became plugged with fibrin, but no one seemed to appreciate that the whole tube might as regularly be encapsulated in similar material, and when occasionally observed, it was considered a chance occurrence. Laparotomy came to be no longer considered *the* indication for drainage, even by many of its most enthusiastic supporters, including Olshausen, and eventually Sims himself. The use of drainage became limited to certain conditions, the nature of which provoked a discussion which is yet to be closed.

Reaction against Routine Drainage. — This reaction against prophylactic drainage was greatly influenced by the growing recognition of the importance of antisepsis. Schroeder (19), in 1875, declared that it was not the avoidance of the peritoneal secretion that was important, but the care not to infect it. In 1879, Loebker (20) maintained that inasmuch as the vagina could not be sterilized, a tube here was always dangerous. Although there was an increasing skepticism about the efficacy of the methods of drainage in use, there was no abatement in the efforts to overcome the obstacles to a lessened mortality and a more satisfactory convalescence. Many were the procedures devised. In 1880, Neuber (21) introduced absorbable drains made from decalcified pipe bones; Bardenheur (22), in 1881, still loyal to drainage, surrounded a T-tube by a large mass of catgut, vainly hoping thus to promote drainage, prevent adhesions, and permit irrigation. Nichaise (23) recommended the use of red or black rubber drains, rather than the gray, which are more irritating, from containing an excess of sulphur. Lewis (24) used bundles of rubber thread, supposedly non-irritating, and easily regulated as to the size of the drain, both in introduction and withdrawal. Martin (25), following Miner's (26) reported subcapsular cystic enucleation in 1872, sought to render dangerous areas extraperitoneal by plastic operations or by the marsupialization of Sacs; Mikulicz (27), convinced of the physical and pathological impossibilities of ideal tube-drainage, emphasized the dangers of dead spaces, condemned irrigation through drainage-tubes, and began the evolution of his tampon by the freer use of gauze, in which last he was not alone, however, as Fritch and Sänger, among others, also used it extensively.

Introduction of Capillary Drainage. — The lack of unanimity of opinion at this time is well exemplified by the ready acceptance of the theory of capillary drainage (gauze) when advanced by Hegar (28), and secondarily by Kehrer (29), as a solution of the problem. This

Kehrer combined with tubular drainage, also inclosing the gauze in a rubber sheath to avoid adhesions, and employed a double tube to permit cleansing of the inner and the removal of fibrin from the outer without withdrawing both at once, somewhat on the principle of the modern tracheotomy tube.

Subsequent Contributions. — Henceforth little that was new was added to means or methods of drainage, though many more or less significant modifications were devised. Championière (30), in 1883, proposed the use of aluminum and celluloid tubes and rediscovered hard rubber tubes. H. M. Sims (31), in 1884, designed a double tube for combined drainage and irrigation; Binnie (32) used tubes of braided catgut, following the lead of Bardenheuer and John Chiene. The latter had used bundles of this material for capillary drainage in the peritoneum. (Various other materials have been used for this purpose,—glass wool, horsehair, silkworm-gut, asbestos, etc., but the authorship is obscure.) In 1885, Shaw (33) rediscovered that tubes should be flanged, and fashioned his after that on an outer tracheotomy tube. Bartlett (34) referred to Ellis's wire tube, but gave no description. Jenkins (35) found virtue in string as a tampon material as well as a means of cleansing the tube through which it was inserted. At this time—1887—Gersuny (36) advocated the use of iodoform wicks, and referred to those prepared with tannic acid used by Billroth. Chrobak (37) combined wick and tube drainage—a rediscovery of Heister's method. Wilson (38), in 1888, described the (Philadelphia) Polyclinic spiral wire tube, very possibly on the same order as Ellis's. The next year, Beyer (39) made his absorbable tubes from animals' arteries, and Mikulicz (40) described his well-known tampon, which Wahler (41) found best applied through a cylindrical tube, which could also be used as a speculum when the gauze was withdrawn, and the cavity repacked through it if it was seen to be necessary. Hughes (42), in 1892, described a rubber dam to be placed over the neck of a drainage-tube as a protection to the wound, neglecting entirely the discharge from about the tube. Maguire (43), in 1893, referred to Morris's cigarette drains, made of gauze surrounded by oiled silk. Hardie (44) published the somewhat new principle of keeping a portion of the incision open temporarily by means of a device similar to a spring eye-speculum, with secondary tightening of the corresponding sutures after its removal, thus avoiding more than a superficial introduction of a foreign body. Kellogg (45) modified Eastman's well by inclosing the inner end of a drainage-tube within a larger tube, thinking thus to facilitate the outflow by preventing adhesions about the inner tube. Baldwin (46) wrote of Rushmore's method of roping gauze after the manner of wringing clothes. In 1898, Heaton (47) described a siphon drain, using the chemist's water-pump for creating constant suction from the tube. Ikawitz (48) described tubes closed at one end to be inserted into wounds for the purpose of catching the secretions (Secrets-auffänger). Bode (49), in 1900, reverted, in his scheme for multiple incisions, drainage, and irrigations, to methods that had already proven fallacious.

In this brief outline it has been attempted to mention only the names of devices and methods in their chronological sequence, indicating roughly the necessities that mothered their invention, and alluding to such details as will be of subsequent importance in this paper.

II. CLINICAL OBSERVATIONS

The views of clinicians upon various phases of problems of peritoneal drainage are too numerous and varied for quotation. Those only will be cited which give a fair presentation of the questions under consideration, and these must be assumed to depend on equally accurate clinical observation. The proof of an established fact is not repeated. Other positive statements receive immediate or subsequent justification.

Conditions Governing Peritoneal Drainage.— As affecting —

a. Drainage through the Vagina.—The practical inefficacy and the actual dangers of this procedure have been so widely appreciated that it has fallen into general disuse, though some few operators still employ it in combating general peritonitis. (This has no reference whatever to such well-established methods as pelvic tamponade with gauze (and tube?) brought out through the vagina, as, for example, in

vaginal hysterectomy, to pack off the field of operation, or in the drainage of pelvic abscesses (peritonitis) when opened through the vagina.)

b. Tube Drainage through the Abdominal Incision. — This can only occur in obedience to natural laws, which are easily determinable. Mikulicz (27) recognized that if intraperitoneal fluid were to run out of a tube, there must exist a certain increased intra-abdominal pressure, vis-á-tergo, which could only be obtained by the application of dressings more tightly than an individual could endure, and, in addition, the tube must be constantly immersed in the peritoneal fluid (as high as the uppermost free orifice), which was impossible because of the immediate intimate application of the omentum, intestines, etc., to the walls of the tube, and the early formation of encapsulating adhesions. Kehrer (28) sought to amplify this by indicating the impracticability of using gravitation, through the impossibility of maintaining patients in a ventral position immediately after the operation, but this question had been already settled by the failure of vaginal drainage. He also observed that the secretion was too slow to permit the use of a siphon. The practical application of this principle "vis-à-fronte" Pozzi (50) attributes to Tait. The tubes were bailed out at frequent intervals, and many were the methods devised for doing this effectually and aseptically. The ulitmate recognition of the uselessness of this practice, the patient's increased discomfort, and the danger of infection brought about its decline from general favor. The different kinds of tubes that have been introduced have, in part, been inspired by the idea expressed by Penrose (51): "Theoretically, an aseptic, unirritating drainage-tube ought never to become shut off by adhesions from the general peritoneal cavity, since adhesions imply more or less irritation." Every tangible foreign body is a peritoneal irritant.

c. Gauze Drainage through the Abdominal Incision.—The visceral and parietal serous surfaces become as immediately applied to gauze as to tubes. This is therefore the same problem modified by the differing physical characteristics of the drain. The outflow here is mainly by the vis-à-fronte (capillarity), and the rougher foreign body is more irritating. Kehrer, one of the earliest advocates of gauze drainage, confessed its limitations by enveloping his drain in rubber to prevent adhesions, and by using in conjunction with it a tube to provide escape for the material the gauze could not absorb.

d. Combined Tube and Gauze Drainage through the Abdominal Incision. — The statements concerning (*b*) the tube and (*c*) the gauze need only be modified to suit the methods of combining these two forms, whether they are inserted side by side or the one partially or completely inclosing the other.

The Main Problem.—The statement of our main problem is now permissible. If drainage of the general peritoneal cavity is possible, it is limited by—1. The time requisite to the functional seclusion of the drain through (*a*) the close application of serous surfaces to the drain and (*b*) its subsequent encapsulation in adhesions; and also by—2. The physical laws governing (*c*) the removal of the drainage material from the tube, and (*d*) the restricted (absorption) capillary action of the gauze. The following evidence should be examined with a view to obtaining some solution of these questions.

The Duration of Abdominal Drainage.—These observations are typical, and are based on the duration of the discharge, and not on its character. Ward (52) found that the flow from the tubes ceased in 12 hours, and from gauze in 24. Robb (53) considered that this varied from 12 hours to 5 days. Körte (54) found gauze strongly adherent in a patient who died 24 hours after the operation. Fowler (55) treated a case by Bode's method, and stated that through-and-through irrigation became impossible at 36 hours. In Hughes's (42) experience, tubes drained the peritoneal cavity 48 hours and the pelvis somewhat longer. Maguire (43) believed that abdominal drainage ceased in 48 hours. Tait (56) found irrigation through tubes impossible after 70—80 hours. Sänger (57) was of the opinion that drainage lasted 2 or 3 days. J. Price (58) observed a free exudate of blood for 10 days. Penrose's observations were antagonistic. In one case, irrigation became impossible in 22 hours; in another, which died 76 hours after operation, the serosa was free and dry. In addition, he quotes drainage of infectious and acetic fluid that lasted from 3 to 11 days. M. Price (59) was of the opinion that so long as there was

anything to drain it would run out, and, as evidence, quoted the prolonged (7 days) discharge from the drained site of attachment of an extrauterine pregnancy.

The results of drainage for the cure of ascites are quite different, but as this treatment is not in favor, little recent literature upon the subject is available. In 1886, Caille (60) reported two cases and quoted three observations of Jacobi's, all of which were in individuals suffering from cirrhosis of the liver. In one there was a discharge from the tube for nine weeks. Nine months later, at autopsy, there was "very little inflammatory reaction in the neighborhood of the puncture." Three other cases were similar, but one of Jacobi's was peculiar, in that the drainage resulted from a spontaneous rupture of the parietes near the umbilicus. All were temporarily benefited.

The subject-matter of the next section is so closely allied to that of the preceding, that they should be considered together.

Amount and Character of Material Removed by Drains. — Allen (61) expressed surprise at the small amount removed by the tube in certain cases. Maguire (43) and Coe (62) both assert that pus and blood are not drained by gauze, nor can any but confirmatory statements be found in this connection. Coe further remarks: "Of course there is always a considerable discharge of fluid, but this is not the septic material we wish to remove." Mikulicz pointed out that the fluid drained is erroneously *not* attributed to irritation (of the drain to contiguous peritoneum), and this is well illustrated by Fowler's cases 3, 4, 7, in which the amount of fluid drained was directly proportional to the amount of drainage used; case 4, in which 21 wicks of iodoform gauze, distributed about the abdomen, not only soaked the dressings but also the bedding. In this connection, Dudley (63) may be aptly quoted. "If, as many claim, it is true that the presence of a drain excites the secretion of fluid, that would not otherwise be secreted at all. It follows, then, that the drain is not so necessary as the large quantity of fluid it carries off would indicate."

There is abundant evidence in the literature that other than this watery fluid escapes from drainage, but this never comes from the general cavity, but directly from the drained areas. The free discharge from a localized peritonitis (encapsulated abscess) has no bearing upon the question of general peritoneal drainage. It, however, illustrates the conditions in a suppurating drain tract. All drain tracts are finally infected but the majority do not suppurate extensively.

Clark (64) found at autopsy that infected pockets occasionally occurred close to the drain tract, and also that the organisms causing the peritonitis might persist in the drain tract after they had disappeared from the general peritoneal cavity. This is of significance in illustrating what a drain does not remove.

A reconsideration of the main problem (*ante*) will insure a more discriminating examination of the succeeding clinical *data*. The time when drainage becomes (*a*) functionally inactive with respect to the general cavity as evidenced by the cessation of discharge is variable; in some cases it is less than 12 hours. Adhesions (*b*) which depend for their production on many extremely variable factors (the local and general condition of the patient, motility of the surfaces nature of the irritant, etc.), are even less determinable. They may, however, be established in less than 24 hours. The discharge from the tube (*c*) begins within the hour of its insertion, as shown by the old practice of bailing out the tube every hour the first day after operation; and (*d*) gauze acts only on the more watery secretions. (The ascites of cirrhosis affects drainage so obviously that it has only a passing interest beyond establishing the fact that continued drainage of the general peritoneal cavity is perhaps possible under certain unusual conditions.)

Two points are not clear: the cause of the early outflow of serum from the tube, and the reason for the cessation of this discharge. The primary serous discharge that all have noted must come from the peritoneum, and that subsequent to the operation and the institution of drainage. No matter what its origin may be, whether from the general peritoneum or from that portion directly irritated by the drain itself, to escape from the tube it must either exist in the general cavity in such an amount (practically an ascites) as to create its own vis-à-tergo and overflow, which has not been observed, or

it must be formed in the immediate vicinity of the tube and thus escape in a path of least resistance. In other words, it must create a vis-à-tergo in a cavity determined by the functional seclusion of the tube, for in no other apparent way could the action of gravity be overcome. If, then, this primary serous discharge is due to the irritation of the tube to the contiguous serosa (an early inflammatory exudate), its cessation can be explained by the production of the fibrinous elements of the inflammation, for this would imply a marked diminution in the serous exudate, and consequently in the amount of drainage, provided there was no suppuration. The fibrinous exudate, in turn, would indicate the actual exclusion of the drain; i. e., the formation of an encapsulated drain tract. These are hypotheses which are equally applicable to gauze drains, but less obviously, on account of the capillarity.

Indications for the Institution of Drainage.—If all the conditions which are believed to indicate the use of some form of a drain were to be literally followed, relatively few abdominal incisions would be entirely closed. Tait's dictum, "When in doubt, drain," has had great influence. Another weighty heritage of that time is the tendency always to attribute fatalities in undrained cases to the sins of omission, whereas the many evil results of the sins of commission are given much less consideration.

The indications for drainage most commonly accepted in modern practice are: 1. The presence, at the time of operation, of an established local or general infection of the peritoneum; 2. The probable subsequent development of such infectious processes; and 3. When, at the termination of operation, there remains material that cannot be spontaneously absorbed (blood-clots, cyst-contents, etc.).

In addition, there are indications for "packing" or tamponade held by those who distinguish between a drain and a pack, though they may use the same material for both, and by a much smaller number who have little or no faith in drainage. These indications depend upon "mechanical conditions of the peritoneum" (Mikulicz); viz., 1. Where there is, or is likely to be, oozing or hemorrhage otherwise uncontrollable; 2. "Dangerous" areas that must be rendered extraperitoneal (abscess cavities, necrotic areas, certain ectopic gestation sac attachments, etc.); 3. To exclude areas that may become dangerous (enteroanastomoses, perforation sutures, choledochostomies, etc.); and 4. The obliteration of dead spaces.

This distinction between a drain and a pack is, in the majority of cases, wholly in nomenclature. The terms are often used interchangeably, and nothing is more perplexing to thinking students than to determine just how the peritoneum distinguishes whether it is being "walled off" or drained.

Methods of Drainage.—Neglecting minor modifications, hard and flexible tubes, gauze, their combinations, posture effects, and lavage need consideration.

Those in favor of the hard tube are particularly fearful that the flexible tube may be displaced by peristalsis (Hyde, 65), or become kinked or compressed. Their opponents point out the very considerable danger of pressure necrosis and fistula formation (Körte, 54), no matter how carefully the hard tubing is introduced.

The believers in gauze drainage must concede to their numerous opponents the right of well-grounded opinion, clearly expressed by Coe: "Gauze acts rather as a tampon than a drain. If we use gauze at all, let us rather regard it as a hemostatic, or else insert it with the legitimate purpose of isolating septic surfaces from the general peritoneal cavity, favoring the formation of adhesions which will render the isolation permanent (?) after the tampon has been removed." The evolution of the modern cigarette drain, gauze enveloped in gutta-percha protective, is affirmatory evidence.

Combination tube and gauze drainage has its speculative and practical advantages. With the gauze inclosed there is possibly more rapid discharge of watery secretion, and if the gauze projects slightly from the end of the tube, it will act as an anchor in the prevention of displacement, while the tube may retard the formation of adhesions above. Such a drain can be removed with relatively little discomfort. Gauze outside of a hard tube receives a firmness seldom needed, and, in turn, in forming a cushion makes pressure necrosis less likely.

The effect of the position of the individual

upon drainage alone affects us; the questions of peritoneal absorption are quite distinct. All attempts to drain the peritoneal cavity from its lowermost part have been failures. Körte found that the method of draining the more dependent portions by multiple incisions beneath them was also useless for drainage, and, moreover, was harmful to the patient. This is probably the consensus of modern opinion.

Peritoneal lavage at the time of operation has little effect upon the reaction of the peritoneum to drainage. It is self-evident that if there were considerable solution in the cavity at the time of closure, it might have mechanical influence upon the relations of surfaces to the drain. The rapidity of peritoneal absorption is so great that any effect must be transient. Post-operative lavage can delay but not prevent the formation of adhesions. Once these have formed, peritoneal lavage loses its purpose, unless sufficient force is used to reopen the general cavity. Inasmuch as asepsis cannot be maintained in the presence of a drain, this certainty of the introduction of micro-organisms into an abdomen that is already abnormal is in itself sufficient to condemn the practice, unless it can be shown that the benefits obtained outweigh the dangers of infection.

Prevention of Adhesions.—With the realization that drains provoke adhesions came futile attempts to prevent them, not only by multiplying the drainage methods, but also by increasing visceral motility. The use of salts for this purpose, probably introduced by Tait, was also advocated by Byford (66), and Hughes (42) advised frequently changing the patient's position. Such procedures could only result in the dissemination of infection, even if they prevented adhesions. The least moved, the soonest mended, is a modified philosophy that is directly applicable here.

Avoidance of Drainage.—Miner discovered the principle of the extraperitoneal treatment of intra- and retroabdominal conditions, that is still used to avoid intraperitoneal drainage. This is also attained by so-called peritonealization of surfaces denuded of their serosa and in certain abdominal cysts by marsupialization. The care with which a competent operator avoids injuring or soiling the peritoneum to curtail or escape drainage well demonstrates the modern tendency to limit its application.

Immediate Effects upon Patients.—Nothing illustrates the fallacy of clinical observation more than the statements in this connection. One faction maintains that undrained cases have less post-operative discomfort. The other asserts the ease with which one may go from bed to bed and pick out the drained cases by the placidity of their facial expression. As a matter of fact, a drain is an irritating foreign body, and, as such, can scarcely be analgesic. Drains have also been held responsible for reflex nausea and vomiting (Clark, 67) and for constipation. The infrequency of these complications suggests an unfortunate, if unavoidable, application of the drain. The late development of post-operative peritonitis (one week) attributed by Munde (68) to drainage is too rare to be more than accidental or incidental.

Indications for the Removal of Drainage.—All are agreed that when the discharge ceases it is time to discontinue drainage. This varies from 20 hours (Cartlege, 69) to weeks. Cushing (70) and Clark both removed gauze (in 4 to 5 days) when it becomes loosened. Clark attributes this loosening to a solution of the fibrin by developing granulation tissue. Intra-abdominal pressure rapidly causes the tract to collapse. Its size and condition determines, like ordinary sinuses, whether it must be kept open distally. Kocher's secondary suture of the wound after the removal of the drain finds but limited application.

Factors Governing the Disappearance of Adhesions.—The formation of adhesions is modified by mechanical conditions. Their disappearance is due almost entirely to them; i. e., the motility of the adherent surfaces (Traube, 71).

The duration of the persistence of adhesions is not determinable, as it depends upon too many factors subject to individual variation,—the extent and density of the adhesions, and the amount and constancy of the movements of the affected surfaces in contrary directions, and the force and amplitude of these movements. Penrose's cases are examples of the disappearance of adhesions. Two patients, treated for pelvic peritonitis, were drained,—

one for seven and the other for twenty-one days. At the end of two years and sixteen months, respectively, when re-operated upon, adhesions existed only between the omentum and ventral hernia sac. The method, form, and duration of the drainage and the after-treatment can evidently influence the disappearance of adhesions.

More Remote Effects upon Patients.—The dangers of the Subsequent development of hernia, fecal fistula, constipation, intestinal obstruction, ileus, and intussusception are only too well recognized. While their occurrence cannot be entirely avoided, it may be greatly limited by the application of the least dangerous method.

Objections to Drainage.—These are as obvious as they are numerous, but, as Martin (25) has said, drainage cannot be entirely discarded. The most insurmountable objection to general peritoneal drainage is, however, noteworthy. From the time that Chassaignac's tubes were found plugged with fibrin, in the unconscious admission of Koeberlé that all serous surfaces applied themselves tightly to his tubes, when he made the apertures small enough to prevent herniæ, and by the proof that Hegar's theory of capillary drainage by gauze was erroneous, and from clinical experience down to the present time, there has accumulated an array of facts that justify this main objection to general peritoneal drainage: it does not drain the general peritoneum.

III. EXPERIMENTAL OBSERVATIONS

These experiments have been physical and physiological, and there has been remarkable uniformity in the results obtained.

Capillary Drainage.—(Extracorporeal experiments.) Thayer (72) compared the action of plain and iodoform gauze on water, and found that the plain took up water the more rapidly, and that both worked faster if the distal end was at a lower level than the proximal end, thereby adding siphonage to the capillary activity. (This has been repeatedly advocated for clinical application.) Cigarette drains seemed to act more slowly even when the sheath of protective was fenestrated. McLean (73) obtained similar results with the use of Richardson's artificial serum. He found, in addition, that moderate pressure upon the gauze has but little effect upon capillary activity. Gauze did not take up pus. Piskachek (74) compared the activity of gauze and braided cotton wicks of equal size. The wicks drained three times as much water in 24 hours, and also acted a little longer. He, too, observed that siphonage added to the rapidity of the capillary action, but that this might be also attained by enveloping the distal end of the drain in dry gauze, which is obviously the effect of surgical dressings.

Experiments on Cadavers.—Helvetius, (quoted by Sänger (75),) Delbet (76), and Mikulicz, injected water into the abdominal cavity, and found that it would never entirely run out again through drainage-tubes. Various attempts were made to simulate conditions of the living body, but with the same results which also followed the exertion of abnormally high pressure. The tubes were always blocked by the application of viscera to the apertures. Mikulicz controlled this by placing coils of inflated human intestine in a basin having an outlet through the bottom. Water then poured into the basin would never completely escape before the outlet became plugged by an intestinal loop. The use of a drain-tube gave similar results. With the aid of colored solutions it was found that none of the pre-existing solution, and not all of that secondarily injected, could be recovered from the tubes. Delbet (77) thus also showed that the irrigating solution reached all parts of the peritoneal cavity. This probably implies the use of considerable liquid, as the peritoneal surface is so extensive. According to Wegner's measurement, it is about 98 per cent of the skin surface.

Experiments on Living Animals.—Preliminary to the consideration of the work done directly upon drainage problems, certain observations are cited as explanation and proof of subsequent statements.

Graser (78), in a very thorough histological study of peritoneal adhesions, arrived at some noteworthy conclusions. Fibrin is concerned in the formation of every adhesion. The more active the inflammation and the greater the endothelial destruction, the more fibrin is produced, except occasionally in the presence of suppuration, when it may be undemonstrable (digestion?). The serosa cells may disappear through

abrasion, desquamation, or cytolysis. Simple continued approximation of serous surfaces does not produce adhesion. There must always be some slight irritation. Exposure to dry air for twenty minutes is sufficient to produce them.

The variation in the severity, nature, and duration of the irritation determines the nature of the resulting adhesions. For example, Elting and Calvert (79) observed in dogs that the adhesion following an infectious peritonitis were weaker, and disappeared sooner (three weeks) than those due to severe temporary but widespread mechanical irritation (organized connective tissue at five weeks).

Eventual infection of the drainage-canal is the rule. Councilman (80) attributes this to the lowered resistance produced by the foreign body along which the skin cocci are prone to travel. Robb and Ghriesky (81) examined the drainage-tube secretion in sixteen laparotomy patients, and even this was infected in seven — six times with the staphylococcus albus and once with staphylococcus aureus.

Wegner's (15) classical experiments showed a dog's peritoneal cavity to be capable of absorbing water at the rate of 3 to 8 per cent of the animal's body weight in an hour, and that under proper irritation it would exude serum with equally marvelous rapidity. In addition, it is probably a fair pathological assumption that fibrinous peritoneal exudates are constantly preceded by serous exudates.

Drainage Experiments on Living Animals.— Von Ott's (82) work in 1878 was done at a time when the question of prophylactic drainage was not definitely settled, and, like much else that lies buried in laboratory annals, his results were capable of profitable clinical application. He inserted through-and-through soft rubber tube drainage in rabbits in such a manner that the tube could, seton-like, be pulled forward and backward. The tube was provided with a string within its lumen, so that coagula might be readily dislodged. Twice a day the string and tube were both moved, and then a two-per-cent chlorinated lime solution was injected into the tube. His results from observation of the living rabbits, or of those dead and killed at intervals, are embodied in the following conclusions:

1. Adhesions usually surrounding the greater part of the tube formed the first day.

2. The tube was isolated from the general peritoneal cavity in three days at the earliest.

3. Serous discharge lasted only one or two days, when suppuration began.

4. Suppurative peritonitis did not occur. Therefore the pus came from the newly formed capsule in the walls of which abscesses occasionally occurred.

5. Neither moving the tube nor injecting into it prevented enveloping adhesions.

6. After the third day injection of the peritoneal cavity was impossible.

7. Discharge of fluid from the general peritoneal cavity did not last 24 hours.

Heinricius (83) repeated von Ott's work, and confirmed both his results and conclusions.

Delbet, in 1889, reported the results of his experiments upon dogs, done under more modern conditions, and imitating as far as possible those of practice. These are given in very brief outline: (*a*) Glass tube placed in the pelvis; two days later, water injected intra-abdominally through another opening did not escape from the tube until the adhesions were broken up by high pressure. (*b*) Another tube-drain was found at the end of two days completely enveloped by omentum, and no "false membrane" was present. (*c*) Two drains — one glass tube and one rubber tube — used. On the third day there was considerable discharge. Dog killed; both drains found walled off; the discharge was therefore from the false membrane (adhesions). (*d*) Two drainage-tubes, glass, and rubber again used. At the end of 24 hours 100 c.c. salt solution injected into the rubber tube. None returned. Animal killed next day. Tube enveloped in omentum. No other adhesions. Eight other similar experiments with glass and rubber tubes and gauze all resulted in the complete walling off of the drain in 48 hours, unless enveloped by omentum, when there was no (other) peritoneal adhesion.

From the results of these experiments Delbet drew the following conclusions:

1. The function of drainage-tubes is contingent upon the obstruction of outlets by intestinal coils.

2. Tubes may become filled with coagula.

3. Capillary drains avoid this, and are therefore superior.

4. Adhesions rapidly form about aseptic drains, isolating them from the general peritoneal cavity.

5. Effectual and durable drainage of the general peritoneal cavity is impossible.

6. Serous discharge comes, in the majority of cases, from the tract about the drainage.

Comparison of these experiments shows that when the variations in methods and in animals are considered, the results are practically identical in their significance. No fact established is in disagreement with legitimate deductions from clinical observations. Our problem can now be restated in a considerably modified form. General peritoneal drainage is a physical and physiological impossibility, because of the functional incapacity of the drain through (*a*) the early application of serous surfaces to the drain secluding it, and (*b*) the subsequent formation (in less than two days) of an encapsulating sheath of fibrinous exudate and adhesions excluding it from the general peritoneal cavity. The drain discharge is the result of an inflammatory reaction flowing out in the (drainage) path of least resistance, from (1) a potential cavity formed by close approximation of serous surfaces, which later become (2) an actual cavity by the action of a plastic fibrinous exudate forming encapsulating adhesions. The nature of the drain is of but relative importance in determining the degree of irritation and the extent of the consequent inflammation. After the drain-tract has once become an extraperitoneal cavity, the physical qualifications of the drain may have a material influence upon the rapidity of discharge.

IV. ORIGINAL EXPERIMENTS

These experiments were done so nearly in the same way that by neglecting the individuality of the animals the results become directly comparable. Dogs were invariably used and treated, so far as possible, like human patients, in order to make the experience gained susceptible of some clinical application.

Methods. — Morphine was given hypodermically, in 1-2 grain doses, according to the size and age of the dog. This made the subsequent ether anesthesia easier, produced prompt emesis and catharsis, and made the post-operative recovery more gradual and more comfortable, eliminating vomiting, and probably decreasing peristaltic activity. Muslin swathes were applied so as to include the whole body, the legs projecting through holes of proper size and shape, and provision being made for the escape of urine and feces. Binders thus applied snugly remained in position, caused no discomfort, and, besides protecting the wound, gave ample support to the abdomen and dressings.

The drains were made the same shape and size, unless very small dogs only were available, when they were somewhat reduced. The gauze, iodoform, bismuth, or plain, was always inserted rolled in the form of a stogie, or with a sheathing of protective, as cigarette drains, so that its effect and that of the tubes should be similar. The drains were therefore approximately the same in size, about 7 cm. long and 4 cm. in circumference, but varied in material and flexibility. The method of insertion was the same. The omentum was always displaced as far upwards toward the diaphragm as possible, and the drains placed downward between the intestinal coils. The incisions were closed snugly about the drains to prevent their displacement. No particular attention was paid to the after-treatment. Water was always provided, but no food was given to animals that were to be killed in a few hours. Ether or chloroform was used for this purpose, but always provoked such active resistance that the strength of intra-abdominal adhesions was severely tested. In the last few experiments it was found that illuminating-gas was far more satisfactory, death was rapid, and almost without discomfort. It is easily administered through a small glass funnel connected by a rubber tube to a gas-fixture.

In order to establish, ante mortem, whether or not the drains were still capable of carrying off intra-abdominal fluid, the dogs were again anesthetized and incisions made just beneath the ensiform, and salt solution, stained red with Orth's lithium carmine, injected by means of a long tube and funnel. The head of the table was elevated, and sufficient liquid introduced to produce dullness above the level of the drain. As a control, a similar drain, similarly inserted,

was often employed. Any escape of fluid along the drain could be sponged with dry gauze and its nature determined.

To avoid confusion, the experiments are numbered in sequence as recorded. Controls were made in every instance where there could be any reasonable doubt as to the validity of the observations. Two forms of drains were often tried on the same animal, so that not only was the comparison more accurate, but each, in a way, controlled the other.

Physical Experiments.—The capillary action of gauze upon pus (empyema), a highly albuminous exudate (tuberculous peritonitis) and a slightly albuminous transudate (ascitic fluid) was tried. The transudate was taken up rapidly, the exudate slowly, and the pus not at all.

To test the rapidity of absorption by gauze, Orth's lithium carmine was used, being more quickly taken up than other stains at hand, and not precipitated. The rapidity of absorption of certain forms of drain was tried. Taking gauze stogies rolled equally tightly, it was found that the smaller the stogies and the deeper the immersion, the more rapid the absorption. Damp and dry stogies were compared. The dry absorbed the lithium solution more rapidly, but the moist took up a greater volume. Four cigarette drains were made with the protective snugly applied in two and four layers, two with the gauze protruding from the lower end, the other two with the protective folded over the gauze and firmly tied in place. These were controlled with stogies made like the gauze within the cigarette. The cigarettes absorbed more fluid with equal rapidity, but it is, of course, possible that if uniformly compressed, as when within the abdomen, this might not follow. No comparison of the rapidity of absorption of bismuth and iodoform gauze was attempted, as the indications for the practical use as hemostatic, and to provoke adhesions, would make any question of the capillary action of minor consequence.

Physiological Experiments.—In the descriptions, stogie drains are referred to as gauze and cigarette drains as protective. Iodoform, bismuth, and plain gauze have been used indiscriminately, as there was no appreciable difference in their effect.

REACTION OF NORMAL PERITONEUM TO DRAINS

SERIES I.—*Experiment* 1.—Right rectus incision; gauze drain inserted at upper and protective at lower angles of wound. After seven days the protective tract was smooth, moist, and firm. The lining was composed of yellowish fibrinous material. No bleeding followed the withdrawal of the drain, which was easily done. The gauze tract was similarly complete. Removal of the gauze drain required force, caused bleeding, and was followed by the discharge of a reddish viscid secretion (cultures negative). The intestines, mesentery, and omentum were involved in the adhesions. The balance of the peritoneum was normal.

Experiment 2.—Same as above. The omentum was displaced upward with more care. Dog was killed after 4 days. Protective tract was smooth, moist, and firm. Protective was easily withdrawn. Gauze tract also complete, but drain was adherent. Force required to move drain sufficient to break down the adhesions, thus opening the peritoneal cavity. Adhesions extended 5 mm. from drain, becoming progressively less dense. Again noted that adhesions about protective appeared more like fibrin than granulation tissue.

Experiment 3.—Same as above. Dog was killed after 3 days. Results were similar. The peritoneal cavity again opened when gauze was removed, and granulations were adherent in its meshes. Viscid reddish secretion was present in the tract. Peritoneum away from drains was normal.

Experiment 4.—Same as above. Practically the same conditions were found after two days. The gauze was even more adherent and its imprint remained on the granulations. Same viscid material was in the tract.

Experiment 5.—Right rectus incision. A small rubber tube was inserted into the gallbladder and fixed by a purse-string suture, inverting the serosa. Tube and apex of gallbladder were enveloped by folds of protective. This was brought out low in the incision, in an attempt to surround the drain with intestines. Tube and protective were easily and painlessly removed two days later. The fistulous tract was intact. It drained two days and then closed spontaneously. The dog remained well.

Experiment 6.—Left flank incision. Polyclinic helical wire drain inserted. Dog killed in 24 hours. Drain tract was water-tight. General peritoneal cavity was normal. A fibrinous exudate not only completely filled the spaces between the wire loops, but partially plugged the tube itself. Superficial dressings were moist but drying.

Experiment 7.—Left flank incision. Glass tube with small lateral orifices and closed base was used. Dog was killed in 24 hours. A fibrinous exudate less extensive than in experiment 6 was found, and the tube contained none. A greater secretion of serum had occurred, as indicated by more moisture in the dressings. Apparently, there was a freer discharge about the tube than the wire. The general cavity was normal.

Experiment 8.—Same as above, except that soft rubber tube with small lateral openings was used. After 24 hours the results were the same as in experiment 7. Lateral apertures were plugged with fibrin. General peritoneal cavity was normal.

Experiment 9.—Incisions in both flanks. Protective drain applied in the right, gauze in the left. Dog was killed in 24 hours. Both drains were completely walled off. There had been a more copious discharge of serous fluid from the protective. Carmine solution was used, and the gauze remained unstained. It was noted that the adhesions had formed not merely between the drains and the serous surfaces immediately in apposition, but had already extended by continuity, as it were, along these surfaces to involve others in immediate contact with them. It was remarkable how much greater had been the reaction on the omentum and mesentery than upon the intestines and parietes.

Experiment 10.—Right flank incision. Gauze drain applied. Dog was anesthetized after 18 hours, and a similar drain inserted in a corresponding position in the left flank. Save for a slight excess of clear fluid, the peritoneum was normal. Carmine fluid was then injected beneath the ensiform, according to the method described. It appeared at the left drain in a few minutes, but there was no leakage from the right in forty minutes, though more solution was constantly added, and at the end the intra-abdominal tension was such that the red solution gushed out of the subensiform incision with each respiration. There had been considerable serous discharge from the drain, as shown by the gauze dressing, but this had ceased some time previously, as the gauze next to the skin and even the end of the drain itself had become quite dry. At autopsy the drain was found to have become entirely extraperitoneal by adhesions of the intestines and omentum to each other, and the parietal peritoneum.

Experiment 11.—Same as above, except that a protective drain was used. When the test solution was injected there was an early escape of the fluid, both through and about the control protective drain, showing good drainage either way. No fluid escaped from the primary drain. The serous discharge had been copious, but had ceased. At austopy, adhesions were found to consist of omentum and parietal peritoneum. The drain was thus entirely encapsulated. (The conditions here were also observed in other experiments, and indicate better immediate drainage from the protective. If the drain is made too stiff and the abdomen is not well supported, there may be a weaker place in the adhesions between the viscera and parietes, particularly when this is not formed by omentum.

Experiment 12.—Right rectus incision. Gauze drain inserted at the upper angle, protective at the lower. Dog killed after 14 hours. No carmine solution used. In the manipulations attendant upon the abdominal examinations, both tracts were broken down, but they had evidently been complete, as the previously adherent areas could be easily recognized, not only where there had been actual contact with the drain, but the immediately adjacent surfaces were thickened and congested. These changes were always most advanced on the omentum, and more so on the mesentery than on the intestine. There was a decidedly more marked reaction about the gauze than the protective. The omentum seemed to penetrate and become adherent within the gauze meshes.

Experiment 13.—Right flank incision. Gauze drain inserted. Dog etherized after 12 hours. The carmine solution was used. Almost immediate escape of fluid from control gauze. None had appeared from the primary drain

after 15 minutes, when the dog was killed. Adhesions of intestines and omentum had completely encapsulated the drain. The gauze was nowhere stained by the carmine. Reaction similar to that of 18 hours, but less extensive.

Experiment 14.—Same as above. Protective drain used. Dog etherized in 12 hours. Same results with carmine solution. At autopsy, adhesions were entirely omental, in spite of extraordinary precautions to prevent this. This illustrates a repeated observation. The protective, being very slippery when moistened with peritoneal fluid, offers less resistance to the omentum, which, by its mobility, easily comes to envelop it completely. The resulting reaction is the same as if the drain were inclosed by several structures, except that there is no extension of inflammation away from the surfaces apposed to the drain (a manifest advantage if other things are equal).

Experiment 15. — Incisions in both flanks. Gauze inserted in the right, protective in the left. Dog killed in 8 hours. Both drains water-tight, and both were enveloped by omentum, but entirely extraperitoneal. There had been the usual amount of serous discharge, which had apparently ceased, as the gauze on the peritoneum was driest nearest the skin about the wound. There was a considerable fibrinous exudate upon the omentum, but this was more extensive at the margins of the incision where the drain had been held constantly in contact with the parietal peritoneum. (Other experiments done without the injection of the fluid showed the same thing.) These adhesions, while unmistakable, are broken up with the greatest ease when manipulated.

Experiment 16.—Same as above. Secondary observations made in 6 hours. Here an excess of intraperitoneal fluid was present. There were no signs of a general peritonitis. Drains discharged none of the test solution under considerable pressure, and again the drains were completely enveloped in omentum. Changes were less marked than in experiment 15, and the adhesions were far less resistant. As before, the greatest reaction was at the margins of the incision about the drains. The gauze dressings were more moist than in experiment 15, but there was the same drying near the wound. (Controls at this period indicate that there is a definite exudate formed by this time, causing adhesions sufficient to wall off the drain, but that these are extremely delicate and easily disrupted by any considerable increase in intraperitoneal pressure.) If the drains are too large and stiff, so that there is constant motion from respiration, there may be no adhesions, but only a reddening of the serosa most constantly in contact with the foreign body.

Experiment 17. — Same as above. At the end of 4 hours there was found a greater excess of clear peritoneal fluid. The control solution escaped freely from both drains almost immediately. There was injection, and a distinct exudate upon the parietal peritoneum at the margins of the wound. The intestines and mesentery were free. The omentum was adherent to both the gauze and protective in places. The gauze dressings were moist, but by no means wet. (Controls gave practically the same result. In one other case the gauze dressings were appreciably dry.)

Experiments 15, 16 and 17 were done in one day, so that relative changes were more striking. The greater excess of peritoneal fluid in the shorter interval is of considerable interest, as well as the regularity with which the most advanced reaction appeared on the parietes where there had been constant apposition of the drains.

Gross Pathological Changes. — There is at first a serous exudate associated with local hyperemia. As the inflammatory reaction increases, a fibrinous exudate is formed and there is more intense local congestion and some edema. The serosa loses its luster and is finally covered with opaque plastic fibrin. This fibrinous surface persists in the presence of smooth drains for at least seven days. Gauze, however, acts differently. The fibrin becomes incorporated in its meshes, followed by an ingrowth of granulation tissue, so that when the gauze is removed, instead of leaving a smooth yellowish surface it is rough and bleeding, with fibrin and superficial tags of granulation tissue still clinging to the more superficial portions of the gauze.

The serous exudate is most abundant during the first few hours (4 to 6), when it becomes noticeably less in amount, and concomitantly there begins the visible deposit of fibrin. This serous excess is manifested during this time by

the wetting of the abdominal dressings, and by the appearance of an increased amount of intraperitoneal fluid, which disappears about the time the isolation of the drain by adhesions is effected.

The character of the adhesions varies with the nature of the drain; the greater and more prolonged the irritation, the more intense the reaction and the firmer the adhesions. This, however, appears in no way to influence the rapidity of the formation of the adhesions nor the completeness of the resulting encapsulation. All serous surfaces, visceral or parietal, react similarly, but vary in degree, apparently directly with the richness of the blood-supply, and inversely with the amount of intrinsic motility and structural firmness.

Minute Pathological Changes.—Tissue was taken from the drain tract at the various periods. The study of the material histologically showed that the reaction processes were practically the same for each variety of drain, but differed in extent, as above noted. One description is therefore sufficient, and, with that single reservation, is applicable to all the conditions studied.

At four hours there is a congestion of the superficial vessels, with diapedesis of red-blood corpuscles and migrations of polymorphonuclear leucocytes in small numbers. A slight, delicately meshed serofibrinous exudate is present, containing these cells in limited numbers, and also a very few desquamated serosa cells. By six hours the exudate is well established, and is no longer easily displaced in the process of preparation. The vessels are more widely and intensely congested, and the exudate is slightly more cellular, but not proportionately to the increased interstitial migration of the leucocytes, which in 8 hours have become amassed in a layer in the more superficial tissues beneath the serosa.

These changes gradually progress with the lengthening periods. The exudate becomes denser and more cellular. It is remarkable to what a slight degree the serosa is affected. The subserosa becomes thickened by cellular accumulations and vascular injection. At 24 hours all these changes are pronounced. The fibrin in the exudate is dense, and the individual filaments coarse, and they have increased relatively faster than the cellular elements, which are present in large numbers. In the 48-hour specimens, the changes, though still more advanced, are similar, and there is as yet no evidence of fixed tissue proliferation. This appears fairly constantly at 72 hours, particularly in the omentum, and is characterized by the presence of fibroblasts and the "sprouting" of capillaries. The leucocytes present in large numbers are beginning to degenerate. (This probably explains why gauze drains become loose after a few days, the breaking up of the leucocytes giving rise to ferments that digest the fibrin enmeshed in the gauze. Later the granulations grow into the gauze again, fixing it even more securely.) With the more advanced periods comes a progressively more mature connective tissue development.

The changes on the omentum and mesentery are constantly more rapid than on the intestine, and more extensive. There is also a very slight variation in the character of the exudate. That upon the intestine contains relatively more leucocytes, whereas the serosa cells are more numerous in that upon the omentum and mesentery. The smooth drains, particularly the protective, possibly provoke an exudate slightly richer in polymorphonuclear leucocytes. These variations are not significantly extensive.

The surface of the exudate apposed to smooth drains is correspondingly even; that next to gauze is rough and shaggy, and filaments of cotton fiber are not infrequently present in such sections.

Reaction of the Peritoneum in the Presence of Infection.—The experiments in series I were done under conditions of relative asepsis. Cultures taken from the peritoneal cavity when the abdomen was secondarily opened were constantly negative. Those from the drain tract, at times negative, frequently contained a staphylococcus albus. To determine the influence of infection, the following experiments were undertaken. A 24-hour boullion culture of staphylococcus aureus of a limited but constant virulence was used. It was given in doses of 5 c.c., usually suspended in 5 c.c. of salt solution. When not introduced through an incision, it was injected through the parietes at a level lower than the drain.

SERIES II.—*Experiment* 18.—5 c.c. of a bouil-

lon culture with 5 c.c. saline solution was injected intraperitoneally. Symptoms of toxemia followed, but none of peritonitis. There was complete recovery. (Control, 36-hour culture used. Results were similar. Dog killed in 3 days. Peritoneum was slightly congested and the peritoneal fluid was somewhat cloudy.)

Experiment 19.—Right rectus incision. All manipulations of introducing a gauze drain carried out, but the drain was withdrawn and the abdomen closed. Cocci then injected as above, with similar results. Dog killed in 6 days. Omentum adherent to the scar. No peritonitis.

Experiment 20.—Right rectus incision. Gauze drain of usual size placed between intestinal coils, but not brought up to the incision, which was completely closed and the organisms injected. Usual symptoms of intoxication followed, and slight abdominal tenderness over region of gauze. Dog killed in 44 hours. General cavity contained slightly turbid fluid. Peritoneum congested, but smooth and shiny. The gauze was completely encapsulated by adhesions, and this cavity also contained a thin, cloudy exudate. (A control killed in 72 hours showed same local conditions, but the general cavity was normal. Another control with 36 hours' culture was followed by death from intense hemorrhagic peritonitis.)

Experiment 21.—Same as above, except that a similar sized piece of sterile potato was introduced. Practically same results were found. Cavity about the potato contained a larger amount of thicker, purulent material. (A control produced a mild general peritonitis.)

Experiment 22.—Right rectus incision. Gauze drain inserted; wound closed; the culture then injected. Signs of intoxication and local tenderness. Dog killed at 72 hours. General cavity normal; drain tract complete.

Experiment 23.—An intraperitoneal injection of culture followed by symptoms of intoxication and slight abdominal tenderness and rigidity. Laparotomy on the fourth day. Fibrino-purulent peritonitis (pure culture of aureus) was present. Iodoform gauze introduced into the left flank; plain gauze into the right. Dog killed in 10 hours. Both drains were completely encapsulated. (Similar observations indicate that a pre-existing non-fulminant peritonitis has no influence on the formation of adhesions, other than possible acceleration.)

Experiment 24.—Left flank incision. Gauze drain applied, followed 15 hours later by an injection of the culture. Dog killed 10 hours later. Drainage had ceased. The peritoneum was normal. Drain completely encapsulated. Cultures from general cavity give aureus and bacillus subtillis. Those from the drain tract were negative. Other experiments of this nature upheld the findings of series I, but were less accurate, as contamination of the drain from the general cavity could never be excluded, owing to the slight resistance of adhesions to manipulations.

In these experiments the question of individual resistance was prominent and complicating. Dogs that developed general peritonitis in the presence of a foreign body showed the most intense inflammation nearest the encapsulating adhesions. The development of peritonitis in the absence of any foreign body, and the absence of general peritonitis when foreign bodies were present, modify conclusions that might be otherwise inferred. Nevertheless, it must be assumed that the presence of a foreign body is detrimental to peritoneal resistance. An assumption that then inflammatory reaction resulting from the presence of a foreign body enhances the power of local resistance to infection is not justified, from the fact that in the presence of normal resistance and the same infection there is comparatively slight reaction, general or local about the point of inoculation.

Bacteriological studies by culture and coverglass show that where the foreign bodies were walled off in the presence of infection the microorganisms persisted within the adhesions. So long as the general cavity contained cloudy fluid, organisms were demonstrable, and even after this, when the peritoneum appeared normal, they might be found as long as 72 hours on the under surface of the omentum.

The more intense reaction immediately about foreign bodies completely within the peritoneum is attributable to the greater pressure within the adhesion capsule, but they are probably little more liable to predispose to general peritonitis, excepting that these adhesions are more likely to rupture into the general cavity,

having no path of lessened resistance leading externally.

Observations on the Resorption of Adhesions.—The determination of the duration of adhesions is of little importance compared with the recognition of the factors concerned in their disappearance. In these experiments it was impossible to be certain what structures became involved in the adhesions without a secondary operation, which was found impracticable, as it added indeterminate complications, but every justifiable precaution was taken to prevent complete omental envelopment of the drain.

SERIES III.—*Experiment* 25.—Left flank incision. Gauze drain inserted and removed after 3 days. Twelve days later the dog was killed. Omental adhesions to the parietal scar alone remained.

Experiment 26.—Similarly done. The gauze removed 7 days later. After 12 days, autopsy showed omental adhesions to scar and a small organized band extending to one loop of intestine.

Experiment 27.—Similarly done. The gauze was removed in 5 days; 14 days after, adhesions between omentum and scar alone remained.

Experiment 28.—Right rectus incision. Gauze drain placed at the upper angel, protective at the lower. Drains removed 7 days later; left rectus incision after 35 days. Omentum and superficial loop of intestine adherent to parietal scar, but not to each other. Nephrotomy and nephrorraphy done through the rectus incision. Large cigarette drain to kidney, at the base of which the gauze protruded and was spread over the kidney. The drain was brought out along the parietal peritoneum, through the incision, and removed in 2 days; 10 days later omentum and superficial intestines were still adherent along the drain tract, which remained firm and patent. The stomach and spleen were involved in a mass of perirenal adhesions.

Experiment 29 (Experiment 5, First Series).—Cholecystostomy. Protective and tube for drain 2 days, discharging sinus for 2 days. Necropsy 13 days later. Omental adhesions present along parietes. The lobes of liver were adherent to each other and intestinal adhesions persisted about the gall-bladder.

Experiment 30.—Right rectus incision. A proximal loop of small intestine was secured, bent on itself, and laterally approximated by two parallel rows of silk sutures about 3 cm. apart, and perpendicular to the long axis of the bowel. Care was taken to avoid touching the serosa thus approximated, and to avoid all possible bleeding from the stitches. This portion was replaced and the same thing done to a more distal loop. Between these rows of sutures a cigarette drain was placed so as to extend down to the mesenteric insertion. A similar drain was also introduced between coils of free intestine, the omentum was then pushed upward, and the wound closed with the drains fixed at either angle. These drains were easily removed three days later. Eleven days subsequently the dog was killed. No traces of adhesions about the free drain were demonstrable. Firm organized adhesions persisted in the tract drained where there had been fixation. The surfaces that had been merely fixed in apposition were now adherent.

Experiment 31.—Similarly done. Gauze was used in place of protective. The drains were removed at the end of 4 days, but with difficulty, and considerable bleeding followed. The dog was killed 10 days later. There had occurred a marked diminution in the size and firmness of the adhesions about the free drain, as compared to those then present where there had been intestinal fixation. Organized adhesions united the surfaces which had been merely approximated.

In even this limited number of experiments the constancy of certain phenomena demonstrates the main factors in the disappearance of adhesions, as already assumed from clinical observations; viz., the primary extent and density of the adhesions and the subsequent visceral movements.

V. DEDUCTIONS

Not only is drainage of the general peritoneal cavity impossible, but, if attempted, there results, on the contrary, a flow from the potential into the general cavity, no matter what form of drainage is used.

The discharge from the drain and the excess intraperitoneal fluid is a serous exudate, the result of mechanical irritation of the peri-

toneum contiguous to the drain, and, to an insignificant extent, of the general peritoneum, from the manipulation attending its insertion.

This serous exudate begins immediately and continues till about the time the fibrinous exudate accomplishes complete encapsulation of the drain by the adhesions of the surfaces whence the serum originated.

The firmness, extent, and rapidity of this encapsulation depend upon the irritation, the nature, reactivity, and quiescence of the affected surfaces (occurring in less than 6 hours in dogs).

The least disadvantageous condition is obtained when the encapsulation is effected by the omentum and parietal peritoneum.

A pre-existing, concomitant, or subsequent peritoneal infection, when not overwhelmingly severe, possibly accelerates the formation of these adhesions.

The presence of a sterile (non-nutrient) foreign body, whether or not encapsluated, is but slightly detrimental to peritoneal resistance.

The less irritating and protracted the drainage, the less extensive the resulting adhesions, which are therefore less liable to be persistent.

The greater the movement of the affected surfaces in constancy, force, and amplitude, the more certainly and rapidly adhesions disappear; but, the greater the intrinsic motility of a surface, the greater the possible functional disturbance from the adhesions affecting it.

Drains with smooth surfaces become as effectively and rapidly encapsulated as those with rough, and being less irritating, the resulting reaction is less severe and the discomfort much reduced.

Drainage from the potential and actual (peridrain) cavities is better in the presence of smooth drains, and their early withdrawal is easy, painless, and without danger of opening the general peritoneal cavity.

The dangers of displacement of a smooth drain can be overcome by inclosing a firm tube, or by disclosing contained gauze for proper fixation to the affected area.

As localized intraperitoneal drainage is alone possible, and is almost invariably associated with early complete encapsulation, it should be purposely inserted to "extraperitonealize" the affected serosa, with the least damage to the rest of the peritoneum and functional detriment to the viscera.

VI. CLINICAL SIGNIFICANCE

There is so little comparison between the peritoneum of a healthy dog and that of a sick man, particularly when the affection is intra-abdominal, that the clinical application of principles thus established must be tempered with conservatism. There is, however, such a well-substantiated and definite relationship between these clinical and experimental observations as to indicate a sufficient physiological resemblance to justify the adoption of such possibly valuable points as are certainly harmless.

The futility of attempting drainage of the general peritoneal cavity, as well as its possible deleterious effect upon peritoneal resistance, together with the certainty of causing immediate and remote complications, however rarely, can have but one interpretation, and this consideration may be limited at once to localized drainage, which, in effect, includes hemostatic tamponade.

We have, then, but to consider how areas already "dangerous," and those that may become so, may be best rendered extraperitoneal until all danger be eliminated. To accomplish this, the isolation must be rapid, complete, and certain, with the least injury to the peritoneum, the least restriction of the normal functions of the viscera, with the earliest and most complete restitutio ad integrum of the abdomen as a whole, and, withal, the minimum of discomfort to the individual.

Any drainage material that can be approximated to the area to be excluded, and so cover it that no abnormal surface but the foreign body appears in the general peritoneal cavity, will accomplish the first purpose. It must extend to the parietes and out through an opening, either the operative incision or one secondarily made for this purpose. In so doing it should come in contact with the least possible number and extent of serous surfaces, and with those least likely to be functionally affected, and therefore between the omentum and parietes, whenever practicable. Everything should be done to promote subsequent intra-abdominal quiet for at least 12 hours, when adhesions will probably be practically encapsulated.

At the end of 24 hours the sheath of adhesions is strong enough to warrant the withdrawal of the core of the drain (which should be constructed on the principle of Mikulicz's tampon) to begin the collapse of the drain tract by the action of the intra-abdominal pressure. Thereafter, as rapidly as conditions will permit, the drain should be reduced until only the sheath remains, and then this gradually removed to insure perfect healing from the bottom.

With the drain removed and the wound healed, measures destined to cause the disappearance of the persisting adhesions should be adopted to stimulate intra-abdominal movements; e.g., purges, general and abdominal exercise, and massage.

Aside from these general principles, there is one detail that adds materially to the patient's comfort,—possibly leads to better results, and is harmless. By enveloping a gauze drain, *after it is inserted*, as completely as practicable with the thinnest gutta-percha tissue, which should entirely surround the whole distal portion and project beyond the skin, those very sensitive cutaneous adhesions are entirely avoided, the intraperitoneal reaction is less severe, and the removal of the drain is comparatively painless, besides being devoid of the same danger of tearing into the general peritoneal cavity. If the protective is not properly inserted, there is danger that it may become displaced, or the whole drain pull out with the first traction.

VII. CONCLUSIONS

Drainage of the general peritoneal cavity is physically and physiologically impossible.

The relative encapsulation of the drain is immediate.

The absolute encapsulation occurs early (less than 6 hours in dogs), and can be retarded, but not prevented.

The serous external discharge is an exudate due to the irritation of contiguous peritoneum by the drain.

There is a similar inward current from the potential into the general cavity.

This external exudate diminishes remarkably with the formation of encapsulating adhesions.

These adhesions, under approximately normal conditions, form about any foreign body. Their extent and density depend on the degree and the duration of the irritation of this body.

Primarily fibrinous, these adhesions become organized in a few days (three days in dogs.)

If the irritation persists, they become progressively more mature fibrous tissue.

After irritation ceases, their disappearance depends principally upon a mechanical factor,—the ability of the involved surfaces to pull themselves or to be pulled loose.

Drains should be the least irritating, and should be gradually and finally removed as soon as possible.

Irrigation through drains is futile to prevent adhesions, and dangerous.

After a drain is inserted, all intra-abdominal movements should be reduced to a minimum.

As soon as the drain is removed, intra-abdominal activity should be stimulated, to aid in the disappearance of the remaining adhesions.

Peritonitis, if not too severe, possibly aids in the rapidity of the encapsulation of the drain.

A drain in the presence of infection is deleterious to peritoneal resistance, and should only be introduced to exclude more malign influences.

Postural methods, unless destined to facilitate encapsulation, are both futile and harmful, as far as drainage is concerned.

Peritoneal drainage must be local, and unless there is something to be gained by rendering an area extraperitoneal, or by making from such an area a safe path of least resistance leading outside the body, there is, aside from hemostasis, no justification for its use.

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TREATMENT OF ACUTE PERFORATION OF THE UPPER ABDOMINAL VISCERA [1]

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THIS paper will be limited to a consideration of perforations of the stomach, duodenum, and gall-bladder arising from internal causes, and taking place so suddenly that time for the formation of limiting adhesions has not been allowed. A discussion of the causes leading to such perforations will not be attempted. Suffice it to state, in passing, that for those of the stomach and duodenum an ulcer may usually be held to account, and for those involving the gall-bladder, the blame must most frequently be laid at the door of cholelithiasis. The importance of the early recognition of these accidents cannot be overestimated. Acute perforation of the viscera of the upper abdomen must be considered as a more serious and more rapidly fatal accident than such perforation occurring in the lower abdomen or pelvis. The reasons for this are obvious. It is a well-known fact that the upper peritoneal area is much more absorbent than the lower; that septic fluids in this region are taken up by the lymphatics with great rapidity, and that the signs of constitutional disturbance ensuing therefrom are extremely rapid in onset and marked in intensity; also, that the fluid contents of the stomach and duodenum, markedly septic, are at the same time quite thin, and their extravasation is apt to be prompt and free. That the contents of a gangrenous necrotic gall-bladder whose drainage has been long shut off are highly infectious is beyond cavil. Finally, these perforations, occurring high in the abdominal cavity, are accompanied by extremely widespread, rapid extravasation of the escaping fluids because of their tendency to gravitate towards the most dependent portion of the cavity. This results in the rapid soiling of large peritoneal areas from the diaphragm to the bottom of the pelvis, and it is a much more swift and certain process than one which, by way of the absorbents, must work from below upwards.

SYMPTOMATOLOGY

In brief, the symptoms of acute perforation of one of these three organs are those of a more or less diffuse and violent peritonitis of the upper abdomen, and, in my experience, usually observe the following order in their appearance:

PAIN

Pain is usually immediate and most severe, the patient throwing himself about from side to side and complaining most bitterly of agonizing pain, which is most intense about the region of the umbilicus, and which is so constant and persistent as to allow him no respite. If asked as to the location of the pain, the patient will usually state that it is general, but close questioning may elicit the fact that at first it was most severe above the navel.

VOMITING

Vomiting has been present in all of the cases observed by the writer, usually appearing shortly after the accident, and recurring every two or three hours. In no case has pure blood been vomited, but in all the vomitus has been dark brown and contained much mucus and bile.

MUSCULAR RIGIDITY

The appearance of muscular rigidity has been most prompt and constant in every case. The abdominal muscles have been contracted to an extreme degree, presenting a boardlike hardness, and rendering the contour scaphoid, except in unusually protuberant abdomens. In the six cases observed by me, it has been possible to demonstrate that the right rectus was apparently more rigid than the left. This was most satisfactorily made out by using both hands, palpating the muscles simultaneously by employing at first but very slight pressure. As this was gradually increased, the right rectus could invariably be found under more tension than the left. In general, the rigidity of the abdominal muscles has appeared earlier and more extreme in degree than in cases observed by me of similar accidents occurring in the lower abdomen.

[1] Read at annual meeting of The Western Surgical and Gynecological Association, at Milwaukee, Wisconsin, December 27, 1904.

FACIES

That indescribable yet pathognomonic expression which speaks so eloquently of some serious intraperitoneal accident is invariably present in cases of this class, and is a sign never lightly passed over by the surgeon of experience.

TEMPERATURE

The temperature in these perforations has has not been a reliable symptom. I have seen it subnormal a few hours after perforation, only to rise rapidly. Again, shortly after perforation an elevation of three or four degrees has been noticed, with a tendency to fall. The temperature in the cases of ruptured gall-bladder has been uniformly high.

PULSE

The pulse has also proven more or less disappointing as an early and pathognomonic index of the condition. Some patients, immediately following the accident, manifest marked shock with a thready running pulse. In others, the pulse shows little acceleration until the signs of peritonitis are well marked, at which time all cases will present the characteristic pulse of peritonitis. As a rule, however, it may be safely said that the pulse-rate shows a constant tendency to rise. I have never seen a case where every hour did not show a more rapid pulse than the preceding hour. As time elapses following the accident, the well-known symptoms of widespread peritonitis become more and more apparent, and are so familiar as to require no enumeration here. Suffice it to say that in the class of cases under discussion their appearance is alarmingly prompt and only too well marked.

DIAGNOSIS

Beyond question, the most important responsibility confronting the attendant in these cases is that of making an early diagnosis. The chance of the patient for recovery rests largely with the first physician called. If he, without attempting to analyze the symptoms and satisfy himself as to the pathology, allows his observation to extend no further than to determine that the patient has intense pain, which must be relieved, and proceeds to administer morphine, much harm will in all likelihood result. Although it takes more than the usual analgesic dose of morphine to relieve pain of this character, it may be so relieved, and patient and attendant lulled into a false sense of security thereby, at a time when the attendant, at least, should be most keenly alert and acutely anxious to satisfy himself as to the cause of the difficulty. Too much cannot be said against the too prevalent and really criminal practice of immediate administration of morphine to every patient with a belly-ache. In attempting to make an accurate diagnosis in cases of this kind, the previous history of the patient will be of great value.

Between perforating duodenal ulcer and a severe and rapid appendicitis, the opinion of the observer may frequently hang in the balance. This is readily understood by recalling the fact that the fluid escaping from a perforation in the duodenum will follow the right colon into the pelvis, setting up almost immediately an inflammation of the peritoneum in the right lower quadrant of the abdomen, which tends to become quickly general, a course pursued also by many cases of fulminating appendicitis. Here the previous history may or may not be of benefit in attempting to differentiate. Careful examination will often reveal more tenderness in the upper than in the lower abdomen, and the muscular rigidity appears more marked above than below the level of the umbilicus. Liver dullness may be absent early, due to presence of gas in the abdominal cavity. The character of the pain is also of value in the differential diagnosis. The pain in appendicitis is generally more or less remitting in type, allowing the sufferer brief moments of freedom from its clutch, while the pain accompanying perforation of the stomach or duodenum is most intense, and noted for its unremitting, constant torture of the patient. Between appendicitis and a perforating gastric ulcer, the diagnosis, while often difficult, will not present so many obstacles. A previous history of ulcer may be frequently obtained, and the course of the extravasated fluid contents of the stomach towards the pelvis may be somewhat checked for a time by the transverse colon, which, acting as a dam, may, in part, retain the septic material in the upper abdomen or divert it to the left, where it follows the left colon into the pelvis. In such cases painstaking examination may show more tenderness and muscular rigidity in the upper

abdomen, extending rather towards the left than to the right inguinal region. However, in other cases the fluid escaping from a perforation near the pyloric end of the stomach may follow the same course as that from a duodenal perforation, when the difficulties of differentiation are increased.

Between gastric, duodenal, and gall-bladder perforation, and those of the intestine complicating typhoid, the history will decide.

The diagnosis between the perforations we are discussing and an acute hemorrhagic pancreatitis presents many difficulties, and may frequently be impossible.

In attempting to differentiate between rupture of the gall-bladder and a perforation of the stomach and duodenum, the previous history of the case is of the utmost importance. A history of cholelithiasis extending over many years, punctuated now and then by attacks of acute chlolecystitis and septic symptoms, together with the fact that the immediate shock of the accident is somewhat less marked and the ensuing symptoms appear more slowly, would suggest the gall-bladder as the seat of the difficulty. Liver dullness is not lost so early in cases of gall-bladder perforations as in those involving the stomach and duodenum. In striving to distinguish between perforating gastric and duodenal ulcer, according to Brunner the most important features are the greater prevalence of ulcers of the duodenum in males and the fact that a history of alcoholism predisposes to duodenal ulceration; also, that in a perforation of the duodenum the extravasated fluid is more apt to follow the colon into the right inguinal region, with evidences of right-sided peritonitis more marked in the lower abdomen and pelvis than upon the left. Time will not permit the further consideration of this phase of the subject. While there are many other intra-abdominal conditions which must be distinguished from the perforations under discussion, I have attempted to mention those with which these accidents are most frequently confused. Those wishing to pursue this portion of the question further are referred to the excellent paper of Frederick Brunner, appearing in *Deutsche Zeitschrift für Chirurgie*, 1903, vol. lxix, to which article I am indebted for mnch assistance in this presentation of the subject.

It will be seen from the above that the conditions for which these perforations are most likely to be mistaken are all serious, and all demand immediate operation, and that while, at times, a differential diagnosis may be made, this, at other times, will be impossible. However, it is contended that the diagnosis of some grave intraperitoneal accident demanding surgical intervention can and should be made in every one of these cases. Valuable time should not be lost in hair-splitting argument as to the exact pathology. Open the abdomen at once, and make the diagnosis and the repair at the same time.

TREATMENT

The writer wishes to state his ideas of the treatment of these accidents, gained from an experience with six cases; two of perforating ulcers of the stomach, one of the duodenum, and three ruptures of the gall-bladder.

The diffuse peritonitis which follows the perforation so closely and which spreads so rapidly is the condition towards the relief of which the early and vigorous effort of the surgeon must be directed. Having decided that such a perforation is present, open the abdomen through the right rectus by a free incision from the ensiform cartilage to or below the level of the umbilicus. This will permit of whatever manipulation may be necessary in any case, as it allows free access to the gall-bladder, duodenum, and stomach. Should the lesion be in the gall-bladder, that viscus is immediately isolated from the peritoneal cavity by properly placed gauze packs, which prevent further soiling of the peritoneum by escaping fluid. If the gall-bladder is gangrenous, necrotic, or its tissues generally infected, it should be at once removed. If the cystic duct is absolutely closed, or the gall-bladder shrunken and atrophic, with its capacity for storage destroyed, again is cholecystectomy indicated. In all cases where ablation of the gall-bladder is performed, free liver drainage through a tube inserted well into the common or hepatic ducts should be provided for. It must not be forgotten at this stage of the operation that the greatest danger just now confronting the patient is the more or less diffuse peritonitis already present, and that prolonged manipulation, engendered by the desire

to make the operation a finished one, will lessen resisting power and favor the spread of the peritoneal infection. We are often prone to do too much. In no class of cases will the penalty attached to prolonged, unnecessary surgery be more relentlessly enforced. Hence I favor saving the gall-bladder if possible, bringing it up and stitching it to the peritoneum in the wound with the usual drainage, as this may be done with greater rapidity and with less manipulation than the more radical procedures. As the contents of the gall-bladder in such cases are highly septic, extreme care should be taken that it is accurately united to the parietal peritoneum, leaving no chance for subsequent leakage. Having disposed of the gall-bladder, attention must now be given the general peritoneal cavity. It will be found more or less soiled, containing bile, mucus, and seropurulent fluid, in quantity and character dependent upon the degree of virulence of the extravasated cyst contents and the length of time elapsing since the accident.

A two-inch incision should be made in the median line of the abdomen, just above the symphysis, and through this a large rubber tube, one to one and a half inches in diameter, split from end to end and carrying a gauze wick, introduced to the bottom of the pelvis. In females the posterior cul-de-sac should be freely opened through the vagina, the low abdominal incision rendering its accomplishment possible in a moment, and a similar tube introduced from the cul-de-sac into the vagina. The abdominal cavity should now be thoroughly washed out with gallons of hot salt solution, care being taken to reach all the fossæ and areas where septic fluid may lie more or less concealed. The upper incision is then rapidly closed with through-and-through sutures, leaving as much of the salt solution in the cavity as possible. Before tying the last suture, more of the saline is introduced through a funnel to take the place of that which has escaped by way of the lower drains. The patient is then raised, while yet on the operating-table, to a sitting posture, which is maintained while transferring him to his bed. He is placed still in the sitting posture in a bed the head of which has been elevated at least thirty inches from the floor. I believe that leaving in the abdominal cavity a large amount of salt solution exercises a very beneficial effect, as this, together with the posture, establishes a strong drainage current in the right direction,—that is, towards the lower pelvis, where it is easily taken care of by the ample drains provided. The indiscriminate and promiscuous introduction of tube or gauze drains here and there in various directions throughout the cavity is considered to be not only a useless but a really harmful practice. Such drains are rapidly shut in by adhesions, drain nothing, and greatly increase the danger of post-operative obstruction. The lowest point of any cavity is the logical point to drain, and when, by posture, we insure the gravitation of the abdominal fluids to the lower pelvis, free drainage at this point is both necessary and sufficient. Three cases of rupture of the gall-bladder into the general peritoneal cavity have been treated as described above, with two recoveries and one death. A detailed description of the cases will be given below.

PERFORATION OF THE DUODENUM

Where the perforation is found in the duodenum, the affected portion should be isolated with gauze packs and the rent or rents immediately repaired. I prefer to make this repair with two layers of Lembert sutures of fine silk.

PERFORATION OF THE STOMACH

When the stomach is the organ affected, close search to find the perforation may be necessary. While perforations of the anterior wall of this viscus are seven times as frequent as those of the posterior wall, and while the lesser curvature is involved eight times to the greater curvature's once, it must not be forgotten that the perforation may be upon the posterior wall or the greater curvature, and these areas, as well as the other and more susceptible regions of the stomach, should be carefully inspected in every case. The fact that more than one perforation may exist should be always borne in mind, and the examination never concluded, even though a perforation has been found and closed, until the entire stomach has been inspected. If necessary to facilitate the suture of the more inaccessible stomach areas, the incision may be extended toward the left along the costal margin. These perforations are also closed with interrupted Lembert sutures of silk

in two layers. I do not favor the purse-string method of suturing visceral perforations. Having repaired the rent in the duodenum or stomach, some operators recommend a gastroenterostomy to insure the future welfare of the patient To this advice I wish to take decided exception. When we have a patient with an acute diffuse septic peritonitis, he will have no future unless we give him every chance, and to give him that, we must do as little to him as possible. If we, by timely, quick, and proper interference, can tide him over the dangers of the acute infection, we can make the gastroenterostomy, should one be necessary, at a later and more favorable time. Again, it seems proper to insist that these patients cannot and will not stand prolonged operations. We should always attempt to do just enough—never too much. After having sutured the perforations in duodenum or stomach, attention must be given the peritoneum. Here, again, we shall find more or less evidence of a rapidly spreading inflammation with more or less septic fluid present. From now on the steps of the operation are exactly the same as described above, everything being done systematically and as rapidly as possible.

One perforation of the duodenum and two of the stomach, due to ulcer, have been so treated, all the cases recovering. Reports of the cases mentioned in this article follow.

CASE 1.—Rupture of gall-bladder into general peritoneal cavity. No adhesions. Operation sixteen hours after rupture, following technique described above. Recovery prompt and uneventful.

CASE 2.—Seen with Dr. Cruickshank, of Vermilion, South Dakota. Rupture of gall-bladder into general peritoneal cavity. Operation twenty hours after rupture. Same technic. Recovery slow, and for a time doubtful, but finally complete.

CASE 3.—Mrs. E., aged thirty-nine. Seen with Dr. Scott, of Paullina, Iowa. History of gall-stones for eight years. Of late the "attacks" had become more frequent and severe until the present one, which began ten days ago. This was accompanied by more pain than usual with evidences of sepsis prominent from its inception. For the past twenty-four hours, symptoms of diffuse peritonitis present. Pulse 115; temperature 102.5°. Abdomen distended and tender, but patient did not complain so bitterly of pain as the preceding cases. Immediate operation disclosed a large collection of bile-stained purulent fluid about the gall-bladder, evidently confined by the many adhesions present in what was thought to be sharply circumscribed area. This idea led to a fatal error in technic. Disregarding the symptoms which, prior to the operation, had spoken plainly of a diffuse peritonitis, I proceeded under the assumption that it was a localized infection, and, after carefully mopping out the cavity placed therein free tube and gauze drainage. The gall-bladder, full of stones, was not disturbed, as I feared its manipulation might separate some of the protecting adhesions. It was confidently expected that the symptoms of acute sepsis would now rapidly subside, when, with a clean wound, the operation could be completed. The symptoms of diffuse septic peritonitis continued unabated after the operation, and death occurred forty hours later. It was now apparent that I had made a very grave mistake in the conduct of this operation, as leakage was taking place from this presumably walled-off area into the general peritoneal cavity, and the marked symptoms pointing to such an accident should not have been crowded out of consideration by the local findings. I shall ever regret that the same technique employed in the preceding cases was not made use of here.

CASE 4.—Perforating gastric ulcer. Seen with Dr. McLaughlin, of this city. Two perforations of the anterior wall of greater curvature of stomach, with extravasation of stomach contents into general peritoneal cavity, were found at the operation, which was made sixteen hours after perforation, following usual technique. Recovery was uneventful.

CASE 5.—Perforating gastric ulcer. At the operation, made twelve hours after perforation, a single perforation along lesser curvature was found. Extravasation into general peritoneal cavity with extensive soiling. Recovery.

CASE 6.—Perforating duodenal ulcer seen with Dr. Garver, of this city. Operation fifteen hours after perforation revealed small perforation of anterior wall of duodenum one inch below pylorus. Soiling of peritoneum general and widespread. Recovery.

SURGICAL AND PATHOLOGICAL STUDIES ON CALLOUS AND OTHER GASTRIC ULCERS[1]

By EMIL RIES, M.D. CHICAGO

OUR knowledge of callous gastric ulcer is of recent development, and very little is to be found concerning it, even in large monographs on diseases of the stomach. The so-called callous gastric ulcer may resemble carcinoma so closely that its consideration is of the greatest importance for the diagnosis, treatment, and prognosis. The number of cases belonging in this group is so small in literature that even two cases may form a useful contribution to the list.

My first case is the following:

CASE 1.— Mrs. O., 38 years old, July, 1901. In 1894 she was sick with appendicitis for nine days. She had had typhoid fever ten years before. Her menstrual history was without any special importance, except for the fact that for some months before the operation, in consequence of her extreme anemia and emaciation, she did not menstruate at all. Her normal weight was 135 pounds. At the time of the operation she weighed 60 pounds. She had been suffering a great deal from pain in the stomach for a period dating back over two years. She had a feeling of burning in the region of the stomach, which extended up into her throat; had considerable belching; vomited occasionally; sometimes soon after eating, and at other times whether she had eaten or not. She vomited a small amount of blood once, about Christmas, 1900. Her appetite did not seem to be very much impaired; was sleepless on account of pain; and was constipated and thirsty. For about a month before I saw her, she vomited everything she took, even small quantities of water; so that three weeks before she came under my observation, alimentation was carried on through the rectum under great difficulties and insufficiently. Emaciation rapidly progressed, so that the patient presented a terrifying aspect; she looked like a skeleton; her skin was dry, so that if raised up in folds it would stand up for several minutes without smoothing out again. Her temperature was normal, or slightly subnormal; pulse slow, varying between 70 and 88. She was pale. The vascular system presented no abnormalities; the lungs were normal; the kidneys palpable to an abnormal extent in consequence of the extreme emaciation. Her liver was not enlarged, nor were there any nodules which could be palpated on the surface of the liver. The sexual organs were normal. She had no difficulty in swallowing, and a sound could be passed into the stomach, which was not dilated,— in fact, it was very small. In the region of the large curvature, a distinct tumor could be felt on the left side, which extended as far as the median line to the right, and was about three fingerbreadths above the umbilicus. This tumor was movable, and painful on pressure; firm, but not hard; even, not nodular. There were no enlarged glands, either above the clavicle or at any other place; and there were no edemas. One of our prominent medical men had seen the patient, examined her, and pronounced the case carcinoma, as it had been pronounced several times before. Examination of the stomach contents for the presence or absence of hydrochloric acid I omitted.

I decided to operate, and to begin the operation as an exploratory incision, intending to decide upon further operative procedure after the stomach had been exposed. My idea was, that if I found a gastric ulcer I would follow the usual treatment and perform gastroenterostomy. If, on the other hand, I found a carcinoma, and the tumor proved to be as movable as it appeared on external palpation, I would remove the tumor. I operated July 12, 1901, under very good narcosis, the patient taking only about an ounce of chloroform during the operation, which extended over eighty minutes. We began the operation with transfusion and ended with it. The incision was made through the left rectus; the peritoneal cavity was opened without any difficulty. There were no adhe-

[1] This paper appears in French in Pozzi's *Rev. de Gyn. et de Chir. Abd.* Paris, 1905.

sions. The stomach was freely movable, and on exposing it, we found a firm tumor involving the pyloric half of the stomach along the greater curvature. There were no enlarged glands in the lesser or larger omentum. There were no nodules in the liver. I proceeded to do a radical operation. It was easy to tie off the lesser omentum, and I removed one half of the stomach with the pylorus and about an inch of the duodenum. I closed the duodenum with continuous silk suture for the inside, and with a seroserous catgut suture on the outside. I closed the stomach with a silk purse-string suture and over that a continuous catgut sero-serous suture. Then I did a posterior antecolic gastrojejunostomy, taking a loop of the jejunum close to the duodenum, twisting it 180 degrees, attaching it to the posterior wall of the stomach, and uniting mucosa to mucosa with silk and all the rest with catgut. The abdomen was closed completely. The pulse, at the end of the operation, was 140, and very good. The patient made a smooth recovery. Since March, 1902, she weighs 76 pounds more than she did at the time of the operation. She eats anything she desires, and digests her food without any difficulty, eating as much at one time as she ever did before the operation. Her menstruation, also, has returned and is normal.

The specimen shows the following: A large, round ulcer, with sharp edges, which are slightly undermined all around, but not any more so near the pyloric than near the cardiac end of the ulcer. I looked for atypical epithelial growth in this ulcer in about 600 sections which I examined, but there is no indication of any carcinomatous development, or even atypical epithelial growth.

While the stomach-wall outside the ulcerated area is 4.5 mm. thick, it measures 17 mm. in the center and 18.5 mm. at the edge of the ulcer. The stomach-wall underneath the base of the ulcer and all around the edge of the ulcer, as well as the mucous membrane of the stomach for about a centimeter all around the ulcer, is infiltrated with enormous quantities of round cells, both polynuclear and mononuclear. This and considerable amounts of cicatricial connective tissue explain the presence of the tumor. The bottom of the ulcer is covered with necrotic material. The surface of the ulcer consists of infiltrated connective tissue.[1] Outside this zone of round-cell infiltration, the mucous membrane of the stomach is not normal either. We find a condition which is usually described as chronic gastritis; that is to say, we find the openings of the glands enlarged, the glands themselves being tortuous. We find them in close proximity to one another, which indicates an increase in the number of glands,— a hyperplasia as well as hypertrophy.

After the operation was finished, I was anxious to find out whether the pylorus was strictured or not. I tried to pass my little finger, but it did not go through. I tried to pass an artery-forceps, and I could do so without much pushing. One might have thought there was a stricture, but would have been mistaken. If you remove part of the stomach, you will observe after a short time that there is rigor mortis in the specimen. The specimen is stiff; everything that is contractile has contracted, and you have a tight, contracted pylorus, because it is a dead pylorus. When the rigor mortis passes away, the pylorus becomes soft again, and you can easily pass it. This was true in this case, showing that the vomiting had not been due to a cicatricial stenosis of the pylorus.

I found inflammatory infiltration all around the ulcer, the ulcer extending to the pylorus, which might have caused inflammatory stenosis of the pylorus, and might have prevented its normal function; but on examination of the pylorus itself under the microscope I found perfectly normal mucous membrane and normal muscular walls, no round-cell infiltration, — only minute quantities of lymphoid tissue, which we find in every pylorus. Therefore this was not an inflammatory hypertrophy nor an inflammatory stricture of the pylorus.

CASE 2.— Operated on May 5, 1902. Mr. A. F., 43 years old. For twenty years the patient had had pain in the stomach, at first without vomiting, appetite being good. For a year patient was unable to work, on account of pain in the stomach and weakness. His best weight had been 165; when he entered the hospital he weighed 85 pounds. He vomited frequently, at irregular intervals. The vomited

[1] The muscularis mucosæ has disappeared to a large extent in the ulcerated area, and stops almost everywhere at the edge of the ulcer under the overhanging mucosa.

matter, according to his statement, was only bile, never blood, never coffee-grounds. He was constipated. He had constant pain radiating into the back. His appetite was good, but his pain kept him from eating. The patient was unable to lie on his right side. Ten weeks before entering the hospital, according to his statement, he had peritonitis, with severe pain in the abdomen. Afterwards blood passed from the bowel. Medical treatment had brought no relief.

On examination, patient was found extremely emaciated; temperature subnormal; pulse of good volume; urine alkaline, otherwise normal. The stomach was enormously dilated, and reached down to the symphysis. There was an indistinct tumor in the pyloric region. Contractions of the stomach were visible. Stomach-sound passed without difficulty.

The operation, performed under good anesthesia, lasted fifty minutes. Normal salt solution transfusion at the beginning of the operation; incision through the linea alba; peritoneum opened without difficulty. The incision reached to the umbilicus, but the stomach reached much lower down. The stomach was pulled out; the pylorus was found to form a whitish, firm mass, the size of a hen's egg, and firmly attached to the under surface of the liver. Glands were not enlarged. Anastomosis between jejunum and stomach on the anterior wall near the larger curvature with catgut suture throughout, utilizing the Rockwitz twist and the Kappeler suspension. Abdomen closed.

Patient made an excellent recovery, and left the hospital 16 days after the operation. Four months afterwards he weighed 135 pounds, and ate anything he wanted. In March, 1904, he weighed 160 pounds. He is working daily and is in excellent health. I have heard from him again within a week, and he continues in perfect condition. The tumor, which could be palpated before the operation, could not be found on examination in March, 1904.

Both of these cases belong in the group of the so-called callous ulcer, which is characterized by infiltration of its base and edges, so that a tumor becomes palpable if the part of the stomach involved can be palpated at all. The long duration of the disease is commonly observed in these cases. A further feature, which is not always present, is that of a tendency to become adherent to neighboring organs, anterior abdominal wall, liver (as in case 2), or pancreas. A careful study of such cases has recently been given by Brenner (*Archiv. für Klin. Chir.*, vol. lxix, 1903). What interests us specially here is the relation of these ulcers to the differential diagnosis between ulcer and carcinoma, and the question of treatment.

In both of these cases the age of the patients, their cachexia, their vomiting, their tumor, the blood in the vomit of the first and in the bowel movements of the second patient, would have warranted a diagnosis of carcinoma, which indeed had been made in the first case by a careful clinician two years before I saw the patient. What caused me not to accept this diagnosis was the very fact that though the diagnosis of carcinoma had been made two years before I saw the patient, the patient was yet alive. In the second case, again, the long duration of the disease was the main reason why I did not make the diagnosis of carcinoma.

In the differential diagnosis between carcinoma and ulcer, neither age nor cachexia, nor vomiting of food or blood, nor the passage of blood with the stools, are of any marked service. All of these symptoms may occur or be absent in either one of these pathological conditions.

The presence of free hydrochloric acid in ulcer and its absence in carcinoma has for years been considered of the utmost importance. But even this sign is not reliable. In ulcer, the amount of hydrochloric acid is not always above the normal, and in carcinoma, particularly carcinoma developed on the base of old ulcer, hydrochloric acid is not always absent or even below the normal. I omitted examination of the stomach contents in the two cases reported, and, as a matter of fact, I pay no attention whatever to this diagnostic means. I have two reasons therefor: 1. That the method is not reliable; and 2. That the necessary manipulations are not without danger.

The presence of a tumor is generally considered a most valuable and practically pathognomonic sign of carcinoma. That this is wrong

is clearly shown by the cases reported here. In case 1 we have, in addition to the excellent condition of the patient's health at the present time,— over three years after her operation,— the evidence of the specimen removed and carefully and extensively investigated. In case 2, though no specimen was removed, the fact that the man is well and fat over two years after the gastroenterostomy is sufficient proof of the non-malignant nature of his tumor. The diagnosis between carcinoma and ulcer evidently becomes almost impossible in certain cases before operation.

What is still more important is the fact that the diagnosis may be just as difficult after the abdomen is opened as before the operation. In the two cases just reported, it was impossible to tell whether the tumor I had in my hand was carcinomatous or inflammatory. With the abdominal cavity opened, we generally have two means of differentiating benign from malignant tumors,— one, the search for metastases; the other, the examination of microscopic slides prepared during the operation. But even these methods are not absolutely reliable. In the first case I found no enlarged glands, no metastases in the liver or anywhere else, but it might have been a primary ulcer with secondary development of carcinoma in the hard edges. The microscopic examination of a piece removed during the operation might therefore have helped. But if we stop to consider that it took over six hundred sections of the specimen removed to make reasonably sure that it was not carcinoma, the question arises, How would the few sections which can be examined during an operation have helped in the diagnosis, particularly if they are negative, as the six hundred sections made after the operation proved to be? In the second case no metastases were found, but the tumor was adherent to the liver, a fact which, if it did not absolutely prove metastasis, at least did not exclude invasion by contiguity

Even apparent metastases do not always necessarily mean carcinoma.

Case 3.— In 1899 I operated on a Mr. K., over 60 years old, who, besides general arteriosclerosis, presented enormous dilatation of the stomach, vomiting, and cachexia. He weighed 114 pounds, while his best weight had been over 200. On operation I found a hard enlargement of the pylorus; enormous dilatation of the stomach, several small, hard, white nodules in the lesser and larger omentum, and one in the liver. I therefore concluded that these nodules were metastatic growths, and I made no attempt to remove the pylorus,but performed a gastrojejunostomy (Murphy button, which has never been passed). Well, the man is alive to-day. His weight has gone up to 160 pounds, and what about the apparent metastases? The microscopical examination of one of these nodules, removed during the operation from the larger omentum, proved it to be endarteritis nodosa, without a trace of anything malignant about it.

Enlargement of the regionary lymph-glands, also, is a very uncertain diagnostic means. It is positively known now, particularly since the extensive operations on carcinoma of the uterus, as I first proposed them (*Zeitshr. für Geburtshuelfe*, vol. xxxii, 1895), have given a new impulse to the investigation of the abdominal lymph-glands, that large glands may owe their enlargement to a simple inflammatory condition, and that small glands may be full of carcinoma. I operated on a case illustrating this in June, 1904.

Case 4.— Mrs. J. F., 33 years old, had had pain in the stomach, radiating out towards the right shoulder-blade, for five years. She had been vomiting for four years; never, however, any blood or bile. In the two months before she came to me she had lost 20 pounds. But her appetite remained good, so that as soon as she had vomited she could eat again. She was pale and cachectic. There was no palpable enlargement of glands anywhere. The stomach was dilated. There was a tumor the size of a goose-egg in the region of the pylorus, which was not very painful. I operated on her June 20, 1904. There were adhesions of the omentum over the tumor, which was large and nodular, and occupied the pyloric half of the stomach. There was a gland the size of a hazelnut in the larger omentum. There were no other enlarged glands, and there were no nodules in the liver. Was it a carcinoma, or a callous ulcer like the two cases reported above? The enlarged gland pointed towards carcinoma. As the tumor was reasonably

movable, I decided to remove it. I resected two thirds of the stomach, made an anastomosis between the rest of the stomach and the jejunum with catgut sutures throughout, and the woman made a beautiful recovery.

Even after I had opened the removed portion of the stomach, I could not tell, macroscopically whether I had to deal with a carcinoma or an infiltrated ulcer. I therefore hastened to examine the enlarged gland, which I had removed. In spite of careful search we failed to find a trace of carcinoma in that enlarged gland, and I felt very happy. But in spite of the negative findings in the gland, the sections from the stomach showed unmistakable colloid carcinoma. The woman has perfect stomachic functions to this day, can eat and drink anything she wants, and has gained in weight. Three months after the operation she began to have pain in her legs, soon paresis of both legs, and paresthesia in the feet developed, and I had very little doubt but that she had a metastasis in the spinal column. But the paresis was apparently due to a neuritis, as the patient has good use of her extremities again and is well in November, 1905. Still, the gland which apparently had been the clearest indication of metastatic growth proved not to be carcinomatous at all.

This last-mentioned case was the youngest of the four cases I have mentioned so far, showing how little importance can be attached to the age of the patient.

Case 4.— Case four taught me an important lesson in another respect. Just as in my first two cases, similar cases reported in literature had lasted a long time, at least years (over two in my first, twenty in my second case). I had considered it a most important point in the history, for instance, of case 1, that the disease had been diagnosed as carcinoma two years before I saw the patient, and that nevertheless she was still alive. On the other hand, I had considered it unlikely that case 4 should be carcinoma, because the beginning of the trouble dated back over four years. Nevertheless, case 4 was carcinoma, and the others were not. So I have learned that this element of duration of the disease is not reliable either.

What remains, then, as a reliable guide to an absolutely certain diagnosis? In a certain number of cases, nothing. The consequence thereof is, that, in the case of an ulcer of uncertain nature, we have to act as if it were a malignant one. Hence the advice, not to be satisfied with gastroenterostomy, but to resect the ulcer-bearing area. I have followed this advice with very happy results in two cases.

Case 5.— Mrs. L. F., aged 36 years. In 1901 the patient had severe hemorrhage from the stomach, after which she was sick for about a month. She recovered, but had constant stomachic pain, belching, constipation. December, 19 and 20, 1902, patient again had severe hemorrhage from the stomach, and melena, from which patient recovered slowly. January 3, 1903, we operated. We found adhesions of the omentum at the pylorus and slight thickening of the pylorus. We did a resection of the pylorus and gastrojejunostomy with catgut sutures throughout. The specimen showed a small ulcer just a little above the pylorus, and another one just a little below the pylorus on the anterior wall, of the sharp-cut, deep variety. The microscopic examination of the ulcer on over one hundred sections proved it to be free from malignancy. The patient made a beautiful recovery, and is now, twenty-three months after her operation, in excellent condition, and free from all stomach disturbances.

Case 6.— Mrs. G. S. R., aged 46 years. Patient has had stomach disturbances for twelve years, which were treated by various physicians, under various diagnoses. Patient never vomited food or blood. She lost some flesh and had constant discomfort in the region of the stomach or gall-bladder. I operated January 1, 1903, in the same way as in case 5. We found adhesions between gall-bladder and pylorus; delicate adhesions of omentum, with a white, thin spot over the anterior surface of the pylorus. The edges of this white spot felt thick and nodular. I resected the pylorus with this ulcer, and again did gastrojejunostomy. In performing the latter operation it was noticed that the stomach-walls were enormously thickened and hyperemic, so that the smallest vessels bled considerably. The tissue at the same time was extremely friable, so that the catgut stitches cut through easily. This specimen showed an ulcer of the anterior wall

of the pylorus, with steep walls, transparent base, and thick edges. A smaller similar ulcer existed on the posterior surface. But the microscopic examination of the specimen on over two hundred sections from various parts of the ulcer did not reveal anything malignant in the pylorus. The patient passed through a slow convalescence, which was complicated by the formation of a peptic ulcer. But the patient is now in good health, weighs 180 pounds, her normal weight, and is able to enjoy an automobile trip through Europe.

In this case 6, the amount of tissue separating the ulcer from the abdominal cavity was so extremely thin and transparent that perforation seemed to be imminent. How much the pathological condition of the stomach-walls had to do with the subsequent peptic ulcer, I shall not further discuss here. The resection of the pylorus in case 6 certainly was preferable to a simple gastrojejunostomy, as the thinness of the stomach-walls left in the base of the ulcer proves sufficiently on the most casual examination of the specimen.

It is often mentioned in the surgical literature of gastric ulcer that considerable time is lost and considerable difficulty is encountered in the search for the ulcer during operation. Where present, the adhesions of the stomach to some neighboring organ, as in case 2 to the liver, or adhesions of the omentum at some part of the stomach, as in our cases 4, 5, and 6, are most valuable aids in the discovery of the seat of the ulcer.

Another indication of the seat of the ulcer is sometimes given by the thickening of the peritoneum of the stomach over the ulcer, as in my case 6, and another one (case 7).

CASE 7.— Mr. F. G., 20 years old. Patient had had two severe hemorrhages from the stomach early in 1903, which made him unable to work for seven weeks. Then he felt perfectly well until in March, 1904, he again had three severe hemorrhages from the stomach, at intervals of a week. He was extremely anemic when I saw him at the end of March of this year. Hemoglobin, 50 per cent; reds, 1,145,000; 32,000 whites. In view of the repeated hemorrhages, from which patient did not seem able to recover, an immediate operation seemed advisable, and I operated on him March 28, 1904. In this case, as soon as the freely movable pylorus was drawn out, we saw a white area of chronic peritonitis on the anterior surface of the pylorus. A vessel starting from the greater curvature disappeared under the white plaque, and reappeared on the farther side. At this place, on palpation, a little thickening of the stomach could be felt, so that we could be sure that here was the ulcer, which had a diameter of about one centimeter. I did an anterior gastroenterostomy (catgut sutures throughout) in this case, because in the weakened condition of the patient the shortest operation with the least loss of blood appeared the best. The operation took, from beginning to end, thirty-five minutes, so that patient left the table in very good condition. He made an excellent recovery, is perfectly well and strong now, has no stomach disturbances, and is able to work.

It was solely on account of the patient's weakened condition that I preferred the anastomosis operation to a resection, because I believed that the saving of blood was of prime importance in this case. Had he not been in such an exsanguinated condition, I should certainly have preferred the resection of the pylorus. I performed the anastomosis with the intention of setting the stomach at rest, and thereby favoring contraction of the stomach and preventing recurrence of hemorrhage. If any of the symptoms persevered in spite of the anastomosis, I intended to add the resection to the anastomosis in a second operation, which would again have been a very short one, as the anastomosis was already done. However, the outcome of the case was so favorable that there arose no necessity of further interference.

I have favored resection of the ulcer-bearing area very earnestly ever since I had an unfortunate experience with anastomosis in 1902. In that year I operated on case 8.

CASE 8.— Mr. P. F. G., 43 years old, who had stomach disturbances for 15 years before I saw him. Patient vomited daily, but never any blood. Had pain in the stomach, and had become used to traveling about with a stomach-pump in his pocket, as the only relief he could find from pain was by emptying his stomach completely with the pump. He had lost 40 pounds within the last year. I operated on him

the same day as on case 2. We found some adhesions between gall-bladder, duodenum, and stomach, but no gall-stones. The pylorus was thick and firm. I performed gastrojejunostomy with catgut sutures throughout as in case 2, and finished the operation in 47 minutes. He made a good recovery and began to gain in weight, but soon he had pain in the stomach again, and had to resort to his stomach-pump as before.

When he returned in September, 1902, he weighed only one pound more than when he had been discharged after the first operation, though at first he had gained eight pounds. I operated on him again, this time with local anesthesia, the operation lasting 45 minutes. The anastomosis made in the first operation was smooth and free from adhesions, but on trying to introduce the finger into the anastomosis by inverting the anterior stomach-wall into it, the opening proved to be almost occluded, I made a new anastomosis, utilizing the old anastomosis for the posterior attachment, and made the opening 10 cm. long.

The patient continued to complain of his stomach after his operation, vomited repeatedly, had slight rises of temperature (highest temperature 100.6°, pulse 82), and a week after the operation his temperature went up to 101°, the pulse to 132, and the patient collapsed. I assumed a leak in my suture and proceeded to operate again. To my surprise, the sutures were in perfect order. The anastomosis had healed completely, but the abdomen contained food, which oozed out from above and behind the stomach. Following up slight purulent flakes on the anterior wall, we came to a perforation in the region of the pylorus on the posterior wall of the stomach, at a considerable distance from the site of the anastomosis. The perforation had a diameter of about 2 cm. Its edges were greenish and the surrounding tissue discolored. I sutured the perforation as well as possible, stitched omentum over it, cleansed the peritoneum, and packed a Mikulicz between liver and stomach. Patient's temperature remained around 102°, his pulse became weak and rose to 140. Five days afterwards, during the dressing, a prune-seed came out of the wound, though the patient assured us that he had not eaten prunes for weeks. Patient died two days later, and in the limited post-mortem which we were allowed to perform we found that the perforation had not healed, and that it was at the bottom of a deep ulcer with necrotic edges. The anastomosis had healed perfectly.

If I had performed resection of the pylorus as the primary operation, the patient would probably have survived, and the adhesions of the gall-bladder to duodenum and pylorus would again have been a reliable guide to the seat of the ulcer. I have therefore adopted it as a rule, to perform resection of the ulcer-bearing area in ulcer of the stomach, if the patient's condition is not such as to forbid an extensive operation, as in case 7.

The reasons why I advise resection instead of simple anastomosis are the following, and the cases reported here illustrate them clearly:

1. Resection cuts the Gordian knot of the differential diagnosis between carcinomatous and benign ulcer.

2. Resection prevents the subsequent development of carcinoma in a primarily benign ulcer.

3. Resection does away with the danger of subsequent perforation of the ulcer.

4. Resection does away with the uncertainty as to whether a large ulcer, particularly if callous, will heal or not.

In extremely emaciated or very anemic patients, it may be advisable to perform the operation in two acts, the anastomosis being done first, in order to stop hemorrhage and permit of proper feeding.

The question whether resection or anastomosis is the proper operation is a particularly difficult one in the case of callous ulcers, such as I describe in cases 1 and 2. From the description of the cases, it is evident that the thickened stomach-walls are so suggestive of carcinoma that where the stomach is at all movable, resection will appear extremely desirable. It also appears eminently satisfactory as to results, as shown by case 1. But, taking a case like our case 2, where there are extensive adhesions to the under surface of the liver, resection will be a difficult and dangerous operation, which a patient with the degree of emaciation which our case 2 had undergone would

be unable to tolerate. In such a case, anastomosis, if only as a preparatory operation, is eminently successful; just as it would be in a case of carcinoma. It leads to great improvement in the patient's general condition, so that, if necessary, the patient can stand an extensive operation after some weeks of proper feeding. Nay, as our case 2 shows, the anastomosis may produce such favorable conditions that even a deep, infiltrated, and adherent ulcer may heal over

Here, as in other fields of surgical work, it is impossible to lay down hard and fast rules. It is necessary to consider every phase of the individual case. After careful investigation of the patient's general condition, the decision as to the exact procedure to be followed will always have to be made in the course of the operation itself. At that time the patient's amount of strength sets the limit for what *may* be done, and the pathologic changes dictate how much *must* be done.

A STUDY OF RANULA

BY PAUL F. MORF, M. D., CHICAGO

TWO cases of ranula, which came under my care about one year ago, directed my attention to this subject.

The first was in a little girl, aged about ten years, who gave evidence of congenital syphilis. There was a tumor, apparently as large as an English walnut, in the floor of the mouth, situated principally on the right side, which had pushed itself over toward the left so that a part of it was located to the left of the frenum linguæ. An attempt at enucleation was made, while the patient was under the influence of a general anesthetic. This procedure was found to be impossible, as the wall of the cyst was so delicate and frail that the slightest touch with forceps was sufficient to tear it into shreds. A wide incision into the sac was therefore made, the glairy viscid contents evacuated, and as much as possible of the wall of the sac removed by dissection. After this the cavity was thoroughly scraped with a sharp curette, and packed with iodoform gauze which had been saturated in the compound tincture of benzoin. This served to stop the bleeding, which was only moderate. While curetting the cavity, it was astonishing to notice that the curette could be passed downward toward the root of the tongue a long distance, about two or two and a half inches, showing that the sac had been somewhat pear-shaped and much larger than was apparent when first examined.

In the second case, occurring in a young man aged twenty years, a smaller tumor was found, which he had noticed only about two weeks. It was then as large as a hazel-nut, but had rapidly increased in volume until at the time when he presented himself for treatment it had reached the size of a pigeon's egg. It received the same treatment as the first, except that the operation was done under local anesthesia with cocain solution, the same difficulties in the enucleation of the cyst being encountered.

Unfortunately, no microscopic examination of the limiting membrane of the cyst-wall was made in either case, the interesting feature at the time being, not the origin of the cyst, but rather its apparently rapid development.

Interest in the subject of this paper has not been exhausted, though ranulæ have been known since the earliest times. This is, in a great measure, due to the fact that the etiology was for a long time obscure, and that consequently there was an opportunity for numerous theories and conjectures as to the true origin. The subject was made more complicated because various pathologic conditions were classed together as ranulæ which have little in common, except that they are all located near the base of the tongue. Sublingual lipomas, abscesses, dermoid cysts, echinococcus cysts and true cystic tumors

were all grouped together, and the general term "ranula" applied to all of them.

Hippocrates considered ranula a local inflammatiory process, and spoke of it as "hypoglossitis." Celsus had a similar idea, and described ranula as an abscess with a wall. Ætius considered it a varicose dilatation. Paré described it more fully, but ascribed its development to the descent of "pituitary matter" from the brain to the tongue.

Since the sixteenth century, when anatomy was established as a science, and, as a result, the exact anatomy of the salivary glands came to be better known, a nearer approach to the true origin of ranula was possible. Jourdain and Louis attributed its development to a retention of saliva in the excretory ducts of the salivary glands, by reason of a thickening of saliva, or an obliteration of the large ducts of these glands.

The view that ranula resulted from the stenosis or obliteration of these ducts, especially Wharton's, or from the presence of a foreign body such as a stone in the excretory duct of the submaxillary gland, is the one which has been generally held up to a comparatively recent time. While it cannot be denied that this can be the cause in some instances, it is probably the exception rather than the rule. Richet reports a case in which Wharton's duct was obstructed by the presence of a small piece of straw, causing a cystic tumor to appear in the floor of the mouth. A cure was effected by removing the obstruction by repeated catheterization. Out of fifty cases of ranula operated by Sonnenburg, two were found to be the result of the presence of a calculus in Wharton's duct. Senn states that he has seen several cases of dilatation of Wharton's duct reaching the size of a walnut, and was able not alone to see the orifice of the duct on the cyst-wall, but by pressure to empty the cyst contents through the constricted orifice. Obliteration or atresia of this duct is not always followed by the development of a cyst. This is proved by an unusual case described by Sultan, and by the fact that experimental ligature of a gland-duct is not always followed by a cystic dilatation of the same. Sultan observed a congenital atresia of both of Wharton's ducts in a child of three and one half months. They projected into the mouth as two horn-shaped processes, on each side of the frenum linguæ, but had not given rise to the growth of cysts.

There are a number of additional reasons why we must look elsewhere for the origin of ranulæ: 1. Few ranulæ correspond to the location of the submaxillary gland, which would not be the case if ranulæ were frequently the result of obliteration or obstruction of its excretory duct. 2. Wharton's duct is usually found to be patent beside the ranula. 3. Cutting a duct of one of the salivary glands very often leads to the formation of a fistula. Opening a ranula by simple incision, on the contrary, leads to no such result, but is followed by a rapid healing of the wound and a speedy recurrence of the condition. 4. Placing salt or other sapid substance stimulating salivary secretion on the tongue causes no increase in size of the cyst, a result that would be expected were the tumor the result of obstruction of a large excretory duct. 5. The contents of these cysts does not correspond in its chemical composition to saliva. It is not reddened by ferric chloride, which shows the absence of potassium sulphocyanide, neither is there any ptyalin present, as is shown by its inability to change starch into sugar (Weber).

It was a result of the knowledge of these facts that pathologists looked for a different pathogenesis. Fleischmann called attention to the existence of a mucus bursa, which he described as being situated beneath the mucous membrane of the tongue beside the frenulum linguæ, lying on the genio-glossus muscle and behind Wharton's duct and the ducts of Rivini. He claims to have found this bursa constantly on one side or the other. He considered it as the starting-point of ranulæ. Later investigators (Virchow), however, were unable to find the bursa at all, or, at most, found it only rarely, so the idea that the ordinary ranula is a hygroma of this structure has been abandoned. At most, we can say that only very exceptionally is this bursa the starting-point of the trouble.

Another step toward the solution of the mystery of the origin of ranula was made when Tillaux discovered the accessory sublingual glands.

Dupuytren, in 1839, gave a good description

of the different varieties of ranula. He seems to have had the idea that ranula might develop from the submaxillary and sublingual gland-ducts, as shown by the statement that ranula "is a tumor resulting from the accumulation of saliva in the excretory duct of the submaxillary gland, and sometimes in those of the sublingual gland, but the latter occurrence is much more uncommon." This statement seems to have been largely conjectural, as he states farther on: "However, that which is certain is, that there is not a single anatomical demonstration of the seat of ranula."

It is to von Recklinghausen that we owe the first exact anatomical demonstration of the origin of ranula. Although he was probably in error in generalizing too freely from his careful microscopic study of a single case, the importance of his contribution to this subject can hardly be overestimated, as it was thereby brought into prominence, and an impetus given to further investigation.

While making a *post-mortem* examination on a female aged forty years, von Recklinghausen found a ranula situated in the classic location, there being no connection whatever between the cyst and the submaxillary or sublingual glands or their ducts. On the contrary, it was found to be firmly connected with, and forming an intimate part of the gland of Blandin and Nuhn, the remains of which formed a part of the cyst-wall. The chief duct of the gland opened into the cyst, von Recklinghausen's conclusion being that the whole cyst consisted of an enormous dilatation of one of the main intraglandular ducts.

This case would seem to establish definitely that a ranula may develop from the lingual gland, or, as it is otherwise known, the gland of Blandin and Nuhn. According to von Recklinghausen, this gland is quite variable in its development. Sometimes it is large, the glands of the two sides being symmetrical, well-defined bodies, sometimes the glandular masses are more scattered, and sometimes are altogether absent. In the majority of cases the main portion of the gland lies on the under side of the tongue, at a point where the mucous membrane makes the fold to pass to the frenum. The posterior processes of the gland regularly extend backward toward the base of the tongue, into the space between the genio-glossus, and the hyo-and stylo-glossus muscles. If, therefore, the ranula develops from that part of the gland lying near the tip of the tongue, the cyst will lie above and anterior to the opening of Wharton's duct. If it grows from the middle portion of the gland, it will from the beginning lie in the floor of the mouth behind the duct of Wharton. If, lastly, it develops from the hindermost part of the gland, the cyst will extend toward the hyoid bone in the above-mentioned connective tissue space, which may cause it to take on a conical, pear-shaped or glove-finger-like form.

The ultimate cause for the development of the cystic dilatation von Recklinghausen seeks to find in a chronic inflammation around and about the smaller gland ducts — a "chronic myxangioitis." He assumes from results of his microscopic examinations that the inflammatory process remains restricted to a part of the gland, and becomes intense enough only at certain places to cause obliteration of a single or several ducts. Increased secretion, due to the inflammation, together with the obliteration of a duct, is the combination which gives results favorable for the development and growth of a cyst. When this has reached a moderate size, perhaps that of a hazelnut, it begins to make pressure on the surrounding connective tissue, which is thereby drawn into the pathologic process and helps to form the cyst wall.

The ranula developing from these small gland-ducts has an epithelial lining corresponding to that of the ducts. Now, not all ranulæ have a lining of flattened epithelium, a number having been described that, on microscopic examination, showed ciliated columnar epithelium. Von Recklinghausen attempts to class these with those developing after the manner described by himself, claiming that in the course of growth of the cyst the pavement epithelium becomes changed to the ciliated variety. This explanation does not seem satisfactory, especially as another and better one has been found.

In 1867 Bochdalek described the canal which has been named after him. This canal although known to the older anatomists (Vater, Morgagni, and Heister), had come to be for-

gotten until Bochdalek again directed attention to it. The canal, when present, begins at the median glosso-epiglottic ligament and passes forward, ending at the foramen cecum. It has a number of lateral processes, forming muco-glandular acini, which open into the principal canal. Further, Bochdalek noted several branching passages starting from the main duct, and running downward and forward between the fibers of the genio-hyo-glossus muscle, terminating in branched blind pouches. These latter, as well as the main canal, also, are lined by columnar ciliated epithelium. The ducts were found constantly to contain a clear, slightly reddish mucus. The canal of Bochdalek, developmentally, is a part of the ductus, or rather " tractus thyreoglossus " of His, and is the remains of the median " anlage " of the thyroid gland. The tractus thyreoglossus is described as extending from the foramen cecum of the tongue to the isthmus of the thyroid gland, and in the embryo communicates with the oral cavity. Its remains have been traced downward through the body of the hyoid bone to the apex of the thyroid isthmus. It is well known that this structure is responsible for the origin of other pathological anomalies. Median fistulæ of the neck and dermoids of the tongue are associated with vagaries of the thyreoglossal duct (Bland Sutton). Accessory thyroid glands, from the base of the tongue to the apex of the processus pyramidalis of the thyroid gland, are not uncommon. Allen, in a recent number of this journal, records a case of accessory thyroid found in the region of the foramen cecum, and quotes a number of other cases.

Streckeisen found accessory thyroids from the hyoid bone to the thyroid cartilage, which had developed from this fetal remnant. He also found cysts lined with ciliated epithelium within the body of the hyoid bone of adults, which had developed from the tractus thyreoglossus in six out of twenty cases examined. Out of a series of one hundred and fifty cases, he seven times found cysts lined with ciliated epithelium near the hyoid bone, either in the middle line between the genioglossi muscles or in the substance of one of these. These varied from hempseed to pea-size, and contained a clear, slightly yellow, mucus-containing, glycerin-like fluid. One can easily imagine one of these cysts increasing in size, presenting in the floor of the mouth and giving the clinical picture of ranula.

A number of cases of ranula developing from the canal of Bochdalek or other remains of the tractus thyreoglossus have been recorded. Among these are cases reported by Neumann, Hildebrand, von Hippel, Poschen, Cambria, Sultan, and Försterling.

Another structure from which ranulæ may grow has been pointed out by Suzanne. He made numerous careful anatomical dissections of the floor of the mouth, which brought him to the conclusion that a large number of ranulæ originate in the sublingual salivary glands. Von Hippel agrees with him in considering the sublingual glands the starting-point of many cases of ranula. Von Hippel's careful study of the microscopic findings of a case of ranula has proved conclusively that these cysts do, in some instances, arise in the sublingual gland, and he has also added materially to our knowledge of how they develop. Like von Recklinghausen, he found evidences of a chronic interstitial inflammation, which results in an obliteration of the small ducts that lead from the acini of the gland, and later causes a sclerosis of the acini themselves. The glandular epithelium, however, remains functionally active for a time, leading to a dilatation of the stenosed or obliterated ducts, and a mechanical stretching and thinning of their walls. The microscopic cysts so formed gradually increase in size until their walls come in contact. This increase in size is the result of the accumulating secretion, and to a transudation of fluid from the numerous capillaries of the cyst-walls. The mucus element of the cyst-contents is furnished by a breaking down of the epithelial lining of the cyst. Where the limiting membranes of the small cysts come in contact with each other, they break down, owing to insufficient nutrition. In this manner larger cysts are formed. In the event of the cyst-walls lying in contact not breaking down, a multilocular ranula results, a not uncommon event. These deductions were drawn by von Hippel from the study of a ranula developing from a sublingual gland, and he thinks it probable that those ranulæ which lie more anteriorly in the

floor of the mouth than seems compatible with the position of the sublingual gland develop in a similar way from the glandula incisiva.

Von Hippel's conclusions are confirmed by Mintz, who found a ranula the size of a hen's egg in a female aged twenty years. The sublingual gland was intimately connected with the wall of the sac. His microscopic study of the case led him to agree with von Hippel as regards the development of the cyst from the small excretory ducts, following an interstitial inflammatory process.

It is thus evident that the term " ranula " can be used only to designate a clinical condition, and not in any way to denote a pathological entity. If it were possible to say from the position of a ranula from which organ it originated, it would be preferable to speak, for example, of a cyst of the gland of Blandin and Nuhn, or of the sublingual gland, etc. As, however, it is necessary to make a careful macroscopic and microscopic examination of the cyst after its removal before its exact origin can be stated with certainty, the retention of the term " ranula " is desirable.

Regarding the time which is necessary for a ranula to develop, it is difficult to make definite a statement. Cases of so-called acute ranula have been described, and are comparatively numerous. Two instances cited by Gross and Vautrain may be accepted as illustrations. In the first the tumor was said to have appeared suddenly during an epileptic attack. In the second the patient suddenly felt a severe pain beneath the tongue while eating, and one hour later a tumor as large as a walnut was seen in that situation, which interfered with deglutition and speech. Keeping in mind the studies of the etiology of these cysts, the probable explanation of these and similar cases is, that a small ranula, perhaps deeply situated, was present previously, but had remained unobserved. A sudden increase in size then occurred as a result of trauma, which caused either an active transudation from the numerous capillaries of the cyst-wall, or perhaps a hemorrhage into its cavity. This eventuality is illustrated by a case reported by Forget, who was called to see a woman in danger of asphyxia. The patient was found with the mouth wide open, and containing a tumor the size of a hen's egg, filling the mouth entirely. The tumor had appeared one half-hour previously, while the patient was drinking. She gave a history of having previously had a small tumor in the floor of the mouth as large as a hazelnut.

A sudden rapid increase in size of a small unnoticed cyst, causing no symptoms, may also be due to an acute inflammation in its interior, and in the glandular tissue connected with it. Traumatism while eating, or some other accidental injury to an unnoticed small tumor, may cause increased transudation from the cyst-wall, and thus in some cases be responsible for the clinical appearance of an acute ranula.

Congenital ranulæ, although comparatively rare, have been found and reported. Schwerin found a ranula in a new-born infant. Blat found a congenital ranula in a young child, that interfered seriously with the nursing of the infant.

If there has been much uncertainty about the etiology and pathogenesis of ranula, the reverse may be said to be true regarding the signs and symptoms of the disease. Small cysts, as noted above, may remain undiscovered, and force themselves on the patient's attention only when a sudden enlargement occurs. A cyst of moderate size usually makes its presence felt by interfering with some function of the tongue or mouth. A cyst of moderate or large size sometimes interferes with speech, causing it to be indistinct and to take on a mumbling character. This mumbling speech has been compared to the harsh croaking of a frog, and this has been offered as an explanation for the name " ranula." As the tumor grows it pushes itself higher up into the cavity of the mouth, and if unilateral, as usually is the case, gradually forces its way also toward the opposite side of the mouth. A large cyst may cause difficulty with mastication and deglutition. In infants, a ranula, even of very moderate size, may be an obstacle to proper nursing, and become a menace to the normal nutrition and to the health of the child. If the tumor grows to a very large size, or is originally deeply situated near the radix linguæ, it may cause dyspnea, and threaten asphyxia, as noted in Forget's communication.

Sometimes severe pain is a complaint of a patient, the pain in some instances radiating

to the ear of the corresponding side of the head. The pain is probably due to pressure on the large trunk of the lingual nerve, which lies in close proximity to the cyst.

The diagnosis of ranula is, as a rule, easily established. A fluctuating tumor which is not tender, and has a dark greenish or bluish color, and located in the floor of the mouth, or near the under surface of the tongue, will usually be found to be a ranula. Exploratory puncture, if necessary, showing a thick, ropy, clear, or rarely blood-stained fluid, should render the diagnosis certain. In rare instances an echinococcus cyst of the floor of the mouth may cause difficulty. Laugier describes a case of this kind which clinically appeared to be a typical ranula. Microscopic examination, however, showed the usual laminated structure of an echinococcus cyst-wall. These cysts are, however, of such exceptional and unusual occurrence, that they need ordinarily not be reckoned with.

Dermoid cysts are rare and have a different contents. Solid tumors and glandular swellings should be differentiated with ease. It must not be forgotten that in some cases the growth of a ranula is more toward the submaxillary region, and in the direction of the hyoid bone, and that the swelling is then more noticeable in these regions than in the floor of the mouth. These varieties might perhaps be confused with cystic lymphagioma of the neck; however, a careful examination will make them clear also, and lead to the right diagnosis.

The treatment of ranula must be according to modern surgical methods. Evacuation of the contents of the cyst after puncture with a trocar and canula is an old and inefficient method, which is followed by speedy recurrence. Injection of the sac with irritants, such as tincture of iodine, either without evacuation or after evacuation of the contents, does not have desirable effects. Besides being an uncertain method, it is not without danger. The results following the injection of such irritants as tincture of iodine, strong carbolic acid, or of a concentrated solution of silver nitrate, into a thin-walled sac situated in such a vascular place as the floor of the mouth, where there is an abundance of muscular and loose connective tissue, cannot always be foreseen or controlled. The method to which preference should be given is excision of the entire sac, under general or local anesthesia. Unfortunately, this is not always possible. As in the two cases operated by myself, the wall of the cyst may be so extremely delicate that it is torn into shreds if enucleation is attempted. In such cases, a wide incision may be made into the sac, the contents evacuated, and as much of the wall as can be removed by dissection. Curettage with a sharp instrument will remove what cannot otherwise be taken away. The cavity should then be packed and healing allowed to take place by granulation. The muscular structures which have been separated by the growth of the cyst soon fall together, materially reducing the cavity in size. If the cyst-walls are firm and sufficiently strong, extirpation of the cyst *in toto* should be practised. If it is apparent that the ranula has grown from one of the salivary glands, this had best be removed also, as the tumor is the result of an inflammation, which may continue in the portion of the gland left behind, and lead to a recurrence of the trouble. While operating, the proximity of large blood-vessels should not be forgotten, for, although the danger of wounding them is slight, and injury might not cause dangerous hemorrhage, it would nevertheless be an annoying complication.

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MY EXPERIENCE IN THE TREATMENT OF RETRODISPLACEMENTS OF THE UTERUS BY OPERATIONS ON THE ROUND, UTEROSACRAL, AND UTEROVESICAL LIGAMENTS.—A REPORT OF 129 CASES[1]

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THE treatment of backward displacements of the uterus, a hackneyed subject, is still of interest to some of us. None the less is this true if some have solved the problem by a new method of fixing the round ligaments in the abdominal wall, a modification of Alexander's operation or of ventrosuspension. About sixty different operations have been devised to remedy uterine retrodisplacements.

It is quite conceivable that the beginner in gynecological surgery would be in great trepidation lest he fail to select the proper one of these for his first case. It cannot be successfully maintained that the larger part of them are not applicable to some cases. The difficulty lies in securing a thorough knowledge of the pathologic conditions in each case, as upon this depends entirely the treatment. The most illogical feature has been the application of some form of treatment without this knowledge. Worse than this, perhaps, has been the tendency to regard the displacement as the paramount or only feature of each case. I believe I am correct in saying retrodisplacement of the uterus, *per se*, requires no treatment. That such displacement predisposes to morbidity of the uterus and appendages I am equally as certain is true. It is safe to state that no woman ever applied for treatment for uncomplicated retrodisplacement of the uterus, and yet this has become the bugbear of womankind. To instill horror into the soul of a woman, one has only to tell her she has a displacement of this organ. Certain it is that a very large proportion of the cases of retrodisplacement are successfully treated without directly treating the displacement. Kleinwächter found that in 41 of 366 cases of backward displacement the organ spontaneously returned to its normal position without the use of a pessary, or any other kind of treatment whatever. In 10 others of his series, this change was produced by the development of tumors of the uterus or ovary. Thus 14 per cent of his cases were cured without aid. Some writers claim that surgical treatment of these displacements is detrimental. Lucy Waite (*Jour. Am. Med. Ass'n*, 1905, xliv, 468–471) particularly condemns such treatment, and especially condemns round ligament operations and ventrosuspension of the uterus.

Yet there will be a large proportion of cases of such displacements that must be treated

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surgically. The etiological features and the existing pathology must determine the nature of the procedure. In a large percentage of the surgical cases the intraperitoneal lesions will be of such gravity as to require abdominal section and perhaps ablation of one or both of the appendages. Probably, proper treatment of these lesions alone will remedy the displacement. In many others, where subinvolution, endometritis, laceration of the cervix or of the vaginal walls complicate, the remedies lie in rest, depletion, improvement of the circulation, curettage, the pessary, etc.

We still find plenty of cases requiring treatment directly applied to the structures that support the organ and maintain its normal mobile position.

At the risk of incurring impatience on your part, I shall briefly consider the various agents that, acting conjointly, maintain the uterus in its position of constant movement, yet fairly well known as one of forward inclination. All the pelvic and abdominal organs covered in part by peritoneum have distinct anatomical positions, though endowed with a certain limited degree of mobility. They all have ligamentary supports, and none other seems to be so liberally supplied with ligaments as the uterus. None of them has freer mobility than this organ, nor is any one of them obliged, in performing its function, to undergo such marked changes in size and physical force as has the uterus. This consequently means great demands upon the tensile strength of its ligaments. The *broad ligaments* are the strongest pair attached to the uterus. They are attached laterally to the whole length of the organ, save the portio vaginalis, and spread out, as they approach the pelvic wall, to a very noticeable extent, being attached posteriorly all along the lateral wall as far back as the sacral promontory. In front, the bony attachment extends well forward, approaching the point under Poupart's ligament through which pass the iliac vessels. Placed as they are, they have to resist the intra-abdominal pressure which is exerted largely against their posterior surface. Bishop (*Med. Press and Circ.*, 1902, N.S., lxxiv, 675–678) and a few other writers do not think they have much to do with maintaining the proper position of the uterus at its normal level. With this view I am not in accord, believing that support to the blood-vessels, ureter, and appendages is not sufficient reason for their being so much larger, proportionately, than the other uterine ligaments. Moreover, their structure and shape are calculated for withstanding resistance. The function of the *round ligaments* seems fairly plain when consideration is given to their uterine attachments at the extreme end of the long axis of the organ, the direction from these points of junction towards the bony attachments, the comparative relaxation noticed in them, and their size and structure. Throughout their intra-abdominal extent they are enveloped by peritoneum loosely attached to them, and within this envelope they each inscribe the arc of a circle. Being attached at right angles to one pole, they exhibit again nature's economy of tissue in its functional activity by having the strongest possible leverage on this axis for the amount of tissue utilized in their structure. But their proportionately larger amount of involuntary muscle fiber and their mobile attachment throughout the extent of the inscribed arc is evidence of their not being planned for great and lasting resistance. To me it would seem their function is gentle and intermittent resistance to backward displacement of the fundus. This function is probably almost entirely limited to such excursions due to pressure exerted on the uterine body by the bladder while being distended by urine. And even in this they are assisted by contraction of the bladder-wall, incident to expulsion of the urine from it, and its attachment to the uterus. The next pair to be considered are the *uterosacral* ligaments, and the opposition to them made by the *uterovesical* ligaments, as well as the function of both sets acting together, makes their consideration together imperative. The uterosacral ligaments are attached to the very lowest part of the supravaginal part of the cervix, and each begins about an inch from the uterine end to spread out into a fan-shaped musculotendinous structure that is attached to the first and second sacral segments. Their function is to prevent the supravaginal portion of the cervix from moving too far forward. The *uterovesical* ligaments, attached to the anterior surface of the uterus almost opposite the attachment of the

uterosacral ligaments, but slightly nearer the middle of the long uterine axis, consist largely of connective tissue and contain a small amount of muscle fiber. In conjunction with the uterosacral ligaments and supported by the fascia in the vaginal roof, they form a strong diaphragm that gives support to the uterus and controls the position of the cervix to which it is attached. It can have little influence over the mobility of the free *portio vaginalis*. In the quadruped the uterosacral ligaments are large and important structures, having most influence in maintenance of the position of the uterus. Professors Dixon and Birmingham (Bishop) describe these ligaments as existing in the human male, attached anteriorly to the bladder base, and they assist materially, through the uterus, in retaining the bladder in its normal position. Even Alexander recognized the importance of the uterosacral ligaments, by saying, in his *Practical Gynecology*, page 61, in speaking of his operation on the round ligaments, "The Hodge, or Hodge and stem, according to the nature of the case, are always introduced just before the operation is commenced. The Hodge should be fairly large, so as to push the cervix well back and relax the posterior uterine ligaments. . . . The stem is removed at the end of the third week. . . . Where there is a weakened perineum, a tendency to cystocele or rectocele, or distinctly relaxed retrosacral ligaments, the perineum must be fortified at the same time that the round ligaments are shortened, or a Hodge's or other pessary, as an inferior support, will require to be permanently worn." Besides the ligamentous supports of the uterus, there are other less important matters that aid in maintaining the uterus in its normal position.

They are:

1. The angle at which the uterus lies with reference to the vagina.

2. The potentiality of the vaginal canal, as opposed to the idea of an actual space beneath the uterus (Bishop).

3. The action of the strong perineal muscles and fascia in maintaining the supporting strength of the vagina and converting an actual canal into a valvular slit in the structures.

4. A postulate balance between intra-abdominal pressure and that of the external atmosphere.

In many cases we find extensive complete perineal laceration with cystocele, and even rectocele, without abnormal position of the uterus. This demonstrates the unimportance of the conditions just mentioned in the maintenance of the normal position of the uterus, and very strongly demonstrates this function is imposed almost, if not quite, entirely upon the ligaments. I cannot accept the view of Penrose, so strenously advocated in his excellent book on *Diseases of Women*, by Watkins, and others, that the peritoneal cavity, being a vacuum, holds the uterus in position by suction as soon as any agent tends to depress the organ. If this were true, then prolapse of the uterus would not be possible, except by destruction of such vacuum by abdominal section, or other method of admitting air into the peritoneal cavity, the formation of gases in the intestinal tract, or the enlargement of abdominal organs. It is not uncommon to find the uterus in normal position and free of adhesons in cases of large ovarian or other abdominal tumors; nor has descensus or other uterine displacement been noted as a result of opening the peritoneum.

COMPLICATIONS

As I have already mentioned, the complications of uterine retrodisplacements require, primarily, our attention.

Probably the most common complication of retrodisplacements of the uterus is endometritis. It is very common, and probably much more frequently follows than antedates the displacement. It therefore has little importance as an etiological factor. It, however, is the complication demanding appropriate treatment, and, incidentally, some procedure may be employed to remedy the faulty uterine position, more especially in the application of the sound surgical principle of removing the cause of a pathologic condition whenever, in the treatment, such is possible. I would not, however, be understood as favoring, under such conditions, any dangerous procedure for bringing about such correction. Metritis, subinvolution, and their accompanying pelvic relaxation, may be, as a rule, placed in the same class as endometritis. Inflammatory diseases

of the appendages with resulting adhesions, infiltration of the uterosacral ligaments with subsequent relaxation, are very common causes of retrodisplacements by pulling the fundus and upper portion of the broad ligaments backward and downward or allowing the cervix to be carried downward and forward. Deep laceration of the cervix destroys the mutual fixed point of attachment of the uterosacral and uterovesical ligaments, allowing the uterus to settle lower in the pelvis, and in a measure destroying the pelvic diaphragm previously mentioned. If such complications as endometritis, metritis, or subinvolution, or any other condition that relaxes the uterine tissues or increases their weight, be added, and this commonly occurs, the uterus will be pushed downward, and the points of uterine attachment of these ligaments swing downward and apart almost in the line of the arcs of two circles inscribed by radii represented by these ligaments taking their bony attachments as centers. With such sagging comes backward displacement. If the fascia adjacent to the lower portion of the uterosacral ligaments be ruptured, as it often is by the same cause, — parturition, — then this process is all the more easily executed. In many cases, even a less degree of cervical laceration may lead to cystic degeneration with hyperplasia of the portio vaginalis, and this, by its increased weight and pressure against the posterior vaginal wall, tends to force downward and forward the lower pole of the long uterine axis. This may gradually stretch the uterosacral ligaments, or even lead to uterine engorgement or inflammation. Elongation of the cervix, either of the supravaginal or vaginal portions, will produce practically similar results. The presence of tumors in the uterus or appendages may, by dragging or pushing the body of the uterus, depending upon their location, cause it to occupy a position lower and farther backward than normal. In a few cases, a floating spleen or a horseshoe kidney has crowded the uterus out of its normal position. Even a dilated and prolapsed stomach has had the same baneful influence. Rarely does a deposis of cicatricial tissue in the broad ligaments contribute to displacement backward. Developmental defects in the attachment of the uterovesical and uterosacral ligaments to the cervix are accountable for many cases of retrodisplacement. Particularly is this noticeable in women who have not borne children. It is not uncommon to find the anterior vaginal wall attached one half or three fourths of an inch too near the free end of the cervix, and quite tense; even in retroversion this causes an abnormally strong leverage, with pulling forward of the cervix. Quite commonly, defects in the posterior ligamental attachment to the cervix are found. The uterosacral ligaments are attached abnormally high to the cervix and often stretched to varying degrees. The effect of these defects is to allow the cervix to approach the pubes too closely, and thus throw the fundus posteriorly, which, in turn, permits intra-abdominal pressure to be exerted on the fundus, and, later, on the anterior wall. Besides these faults with the lower ligaments, the uterosacrals may be torn or badly stretched in child-birth, allowing the cervix to drop toward the introitus vaginæ. Relaxation of the top of the broad ligaments, and even of the round ones, often results from prolapsed and adherent appendages, so common in ancient appendage inflammation. These conditions have led to various operations, that will be mentioned under the heading of treatment.

TREATMENT

After a fair experience with various surgical operations for the cure of retrodisplacements, with probably an average success, I became convinced that the Alexander operation had a very limited field, which could be extended largely by Goldspohn's modification; that vaginal fixation was hazardous; that ventrosuspensio uteri was unsurgical and dangerous; and that the mechanical feature of the forces that maintain the position of the uterus was too much ignored by all procedures then in vogue. The conclusions of my studies contained the belief that the vaginal roof, including the uterosacral and uterovesical ligaments, was the structure largely concerned in holding the uterus in normal position. I therefore, in a few suitable cases, addressed myself to this diaphragm in the surgical treatment of retroversion. In 1901 I abandoned ventrosuspension. In 1902 (*Am. Gyn.*, 1902, vol. i, 35–45; *Jour. Am. Med. Ass'n*, 1902, vol. xxxix, 12–15;

and *Jour. Am. Med. Ass'n*, Nov. 14, 1903) I reported my work to the American Gynecological Society and the American Medical Association. I have now case histories of 61 cases operated on by the vaginal route, and 68 by the abdominal or both combined, making a total of 129 cases with no mortality. This does not include cases in which retrodisplacement was a feature of the conditions present and in which some other surgical procedure was followed. By the vaginal route the round ligaments alone were shortened 21 times, the uterosacral alone 16 times, and both in 24 cases. Various other operations were done at the same sittings; curettage was done in every case; trachelorrhaphy was done 21 times; perineorrhaphy, 23 times; colporrhaphy, anterior or posterior, or both, 14; and in 10 cases adhesions to the uterus or appendages, or both, were separated, and ovaries and tubes resected or removed; in one, inguinal herniotomy was done, and in another, 2 rectovaginal fistula were closed; in 12, transplantation or lengthening of the anterior vaginal wall, including the uterovesical ligaments, was done.

In the 68 cases done by the abdominal route, curettage was done 62 times; trachelorrhaphy, 12; perineorrhaphy, 16; colporrhaphy, 10; removal of one or both appendages, 51; herniotomy, 6; appendicectomy, 49. Pelvic adhesions were separated 49 and diastasis of the rectiabdominales relieved 6 times. The round ligaments were shortened by the Baldy methcd in 60 cases, and the uterosacral in 52.

THE RESULTS

I cannot state accurately, though in a very large per cent, I believe reaching 60, I have examined after the lapse of months and years and have never seen one in which relapse occurred, except in one case following labor. In 6 cases I have had the privilege of examining the patient after labor. I consider the results as nearly perfect as could be expected from any surgical procedure.

From what I have already said, one cannot infer that the procedures just mentioned are self-sufficient. I have endeavored to insist that any pathological condition or etiological factor must be removed. A floating spleen should be removed; a stomach that mechanically acts as an etiological factor should receive appropriate treatment, as should a lacerated cervix, endometritis, injuries to the pelvic fascia, subinvolution, and cervical hypertrophy in any diameters. The sound principles to employ as guides are principally to address our study and treatment to the existing abnormalities, whether of a congenital or an acquired variety, and to regard the displacement as of secondary importance. If injuries to the natural supports of the uterus have occurred, and are plainly the important causal factor, then such repair of them should be made as will restore their functional integrity. Such injury oftentimes takes the form of laceration, but stretching from general weakness, or from inflammatory infiltration, may be the condition found. The uterosacral ligaments may, and often are, stretched by prolonged retroversion from some independent cause, as the presence of a fibroid in the body of the uterus, or elongated cervix, or any of a number of other conditions. When the cause of the displacement is removed, the weakened posterior ligaments may still require splicing, though this necessity is rare. When the relative leverage of the anterior and the posterior sets of the ligaments attached to the lower pole is lost, it should be restored. If the anterior vaginal wall containing the uterovesical ligaments is attached to the cervix at an abnormally low point, the following dissection is made: By means of an incision paralleling closely the anterior cervical wall the vaginal mucosa is separated for one to two inches. The middle of the anterior flap thus made is divided about one half-inch and the angles thus formed are dissected back. The uterovesical ligaments are now grasped by a forceps or lifted out of the incision and severed from the uterus. The uterus, which has been held by a volsellum forceps, is pulled lower and the bladder slightly separated from it. The uterovesical ligaments and the anterior vaginal wall are now sutured to the cervix at a level higher than formerly. The anteroposterior short incision is obliterated in the suturing. Occasionally, a very narrow strip of gauze or rubber tissue is inserted in the wound, where it is left for about one day. If the anterior vaginal wall seems to be too short, the cervix is carried well back before sutures are applied, and the middle of the anterior flap

is held forward. This flap is doubled on itself and sutured, thus changing a transverse open wound into an anteroposterior closed one. Should splicing or other form of shortening the uterosacral ligaments be deemed necessary, it should precede, and not follow, the procedures just mentioned. I have already described the technique of this operation (*Am. Gyn.*, 1902, vol. i, 35–45, and *Jour. Am. Med. Ass'n*, 1902, xxxix, 12–15, and will not reiterate here. The round ligaments very frequently will need to be shortened, a procedure very easy of execution through the incision in the anterior vaginal wall. It requires lengthening the anteroposterior incision 1 to 1½ inches, and, as a rule, extending it also through the peritoneum. A very important matter to be remembered in the after-treatment is to induce the uterine fundus to gravitate toward the symphysis pubes, which I have done by having the patients assume a latero-prone or prone position in bed for 10 to 14 days after the nausea from the anesthetic has passed. It is very necessary to bear in mind that the cervix must be kept well back to prevent retroversion. Retroflection of the body may occur without anterior displacement of the lower pole of the uterine axis; retroversion, never. Very often, — in fact, nearly always, judging from my experience, — shortening the round ligaments at the same sitting is distinctly advantageous. It is principally of value, as the body of the uterus is thus held forward, thereby lessening the tension on the sutures placed in the uterosacral ligaments during the process of healing. The best method of shortening the round ligaments has not been decided. Some methods have special points of advantage, depending largely upon the size of the ligament and upon the question of invasion of the peritoneal cavity. And yet, in most cases, some complication requires intraperitoneal surgery. Moreover, none of these inventors believe appreciable danger is attached to entrance of the peritoneal cavity, under proper precautions. The size of the ligament does guide one as to whether the structure should be looped by some method like those of Dudley, Mann, or Wylie, or drawn taut, as is done by G. H. Noble, Simpson, Ferguson, and Alexander. The Alexander operation seems to be very narrowly limited in its application, except by modification of some sort, the best of which is probably that of Goldspohn, who opens the peritoneal cavity through the inguinal incisions and treats conditions of the appendages. But this requires two incisions, and although I have performed it several times, I prefer the median line incision, with intraperitoneal rather than inguinal shortening of these ligaments. Besides, a few cases have been reported, two by myself, in which the round ligaments did not enter the inguinal canal. A third case was seen last week. In mine, they were attached to the anterior superior spines. Of the intraperitoneal methods, my inclination is for Baldy's operation, reported by him in 1903, at Asbury Park (*New York Med. Jour.*, 1903, lxxviii, 167–169). I believe shortening of the round ligaments and Jonnesco's operation the only logical surgical procedures for retroflexion. The former is always the simpler and more frequently applicable. The operation of Bissell (*Am. Gyn.*, 1903, vol. i, 24, Cleveland), which is termed "Internal shortening of the round and broad ligaments," and that of Slocum (Ibid., iii, 38–43), termed "Cuneiform shortening of the broad ligaments," have, I believe, a field of usefulness, as they are based upon sound anatomical reasons. However, if the ligamental fault be at the lower end of the uterus, they are not indicated, in my judgment. In closing, I wish to draw these deductions:

1. That the complications, rather than the uterine displacement, furnish the cause for surgical relief.

2. All operations done, having in view the correction of uterine retrodisplacements, should be based upon the pathologic and anatomic abnormalities of the uterus and adjacent structures.

3. That any operation that changes one dislocation of the uterus into another is illogical, and hence unsurgical.

4. As a rule, the largest proportion of cases of retroversion of the uterus that require special operations are best treated by proper procedures upon the round and uterosacral ligaments.

HYPERALGETIC ZONES IN GUNSHOTS OF THE HEAD [1]

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SINCE Ross (1), in 1888, advanced the theory that pain sensation in visceral disease is reflected along the peripheral nerves arising from the same section of cord as the sympathetic fibers supplying that organ, research in the field of referred pain has been progressive, without, however, reaching an absolutely conclusive termination. Ross collected numerous cases of referred pain, and his exact knowledge of the distribution of certain sensory roots enabled him to determine with certainty the distribution of pain as identical with certain nerve roots. Relying, however, upon the patient's statements in regard to the area of pain, the results of his investigations were not as positive as one might expect. Marked progress was noted when McKenzie (2), and simultaneously Head (3), described the cutaneous sensibility so frequently associated with visceral disease. This symptom is far more objective than that of pain alone. I shall mention but one or two points characterizing this sensory sign.

a. Sensation is not profound, but located in skin, or at most subcutaneous. One of the best methods (Head) to determine it consists of picking up a fold of skin between the index finger and thumb. In areas where skin rests upon bony support, the head of a pin is used. This offers an advantage over McKenzie's method. He uses the sharp point of a pin in eliciting pain before the affected area is reached.

b. These areas have a distinct connection with the various diseased organs, and in many cases are quite remote from these. The pain produced by irritation is not caused by any action upon the organ itself. Hyperalgesia may be located upon the right side, while the affected organ is located upon the left side of the body, and *vice versa.*

In the course of his investigations, Head established the identity between these hyperalgetic zones and eruptions in herpes zoster. Certain incongruities arose in trying to establish the areas upon the basis of peripheral nerve distribution, like upon that of posterior root distributions. Zones obtained by this method were ill defined, overlapping each other to a considerable extent. Sherrington's (4) investigations upon the distribution of posterior nerve roots led him to conclude definitely that the hyperalgetic zones corresponded to cord segments. Sherrington, in order to determine the area supplied by a certain nerve root, severed all the nerve roots above and below. The remaining area must necessarily represent the distribution of that nerve root. In testing the sensibility of these areas, a test for pain, touch, and temperature was applied, and a change found in all of these, while in Head zones hyperalgesia alone is the prominent factor. The centers of touch and pain are quite remote from each other in the cord, whereas a nerve root will naturally contain all these fibers. Although connected with a great amount of labor, the determination of zones on the trunk in relation to corresponding segments was comparatively easy. Great obstacles arose in applying these methods to the head and neck. Here the segmental arrangement is less evident, and it requires considerable conjecture along embryological lines to render the homology as obvious as in the segments below the first dorsal. The girdle form, however, which the Head zones offer, especially in cases of gunshot of the head, resembles those found on the trunk in visceral disease so strongly that an analogy almost forces itself upon the observer. Most of the observations have been made on medical cases, preferably the more chronic of these. Observations upon surgical cases are few. For instance, referred pain in gall-bladder disease, in stone of the kidney. Quite a number of pains remote from the seat of the lesion are caused by or attributed to direct pressure upon a peripheral sensory nerve; as, pain in the arm and

[1] Read at Chicago Medical Society meeting, December 6, 1905.

[2] I wish to thank my chief, Professor W. E. Shroeder, for permission and encouragement to publish the case. I am also indebted to Dr. M. B. Fyfe, at that time interne, for the sketches.

fingers, due to pressure of carcinomatous supraclavicular lymph-glands in mammary carcinoma; pain in the knee associated with tubercular hip disease, due to pressure upon the obturator nerve. Some of these may prove to be referred pains, rather than due to direct irritation of a sensory nerve, caused by certain vasomotor disturbances in the area. Joint lesions have not so far been included in the circle of observations of this nature. A goodly number of surgical cases are acute, and records upon referred pain under these conditions may shed more light upon this complicated question. Some of these referred pains are of recognized diagnostic value in medicine, such as the referred pain in gall-bladder disease or kidney-stone. From this standpoint a further investigation into the field becomes of eminently practical value for the surgeon. It was with this object in view that Wilms (5) reported four cases of hyperalgetic zones in gunshots of the head before the Thirty-second Congress of the Deutsche Gesellschaft für Chirürgie, and later in the Greuzgebiete (Wilms, 6). In 1896, Schüffner (*Universitäts-klinik*, Leipzig) observed marked hyperalgesia in the neck and head of a man suffering with a gunshot of the head. This case gave rise to further investigation. All traumatic brain lesions, especially skull fractures, with brain lesions, concussions, contusions, without fracture, etc., were examined, but the phenomenon not found. In short succession, Wilms observed it in four consecutive cases which showed a striking similarity of the affected area and the character as well as duration of the hyperalgesia. Similar observations, very incomplete, however, had been made by Brodnitz (1901) and Müller, and were mentioned at the time of Wilms's report before the surgical congress. Milner (7) reported a case in 1904 tallying in every respect with those of Wilms, and shortly afterwards Wilms reported a fifth case.

REPORT OF CASES

Having had the advantage of these well-observed cases and complete reports, the similarity of my own case became at once apparent to me. The patient was admitted to the People's Hospital, in the service of Dr. Schroeder, who was unable to attend. When I saw him about one hour after the accident he presented the following history and symptoms:

David Trautman; aged 32; colored. Admitted November 16, 1904, at 7:30 P. M. Had an altercation with some one, who shot him with a 38-caliber revolver from a distance of about two feet. The patient stated that he heard two shots and felt two bullets strike.

Mental Condition.—Claims not to have lost consciousness. He was in a semi-conscious condition when brought in. He had, however, recovered sufficiently upon my arrival to answer questions with fair precision upon repeated asking. Speech somewhat heavy.

General Condition.—Good; pulse 68; respiration 28.

Wound.—Two round wounds, the posterior one on a level with the right parietal eminence, at a point where a line bisecting the concha reaches the above horizontally. The second wound, about one and a half inches anterior, on the same horizontal. Slight depression palpable over posterior wound. Partial paralysis in left hand and arm. Complete paralysis of face. Some paresis in left leg. This he could use to some extent. Tongue not involved. Eye movements normal. Sphincters normal. Reflexes exaggerated on left side throughout.

Sensory Symptoms.—When examining wounds of the head, I laid my hand upon his neck anteriorly to steady his chin. Although I touched the skin slightly, he cried out with pain. The same occurred in lifting his head at the external occipital protuberance. Pain was produced by gently lifting up the skin between thumb and forefinger; in the hairy portion by gently pulling the hair. Boundaries of the sensitive area presented themselves as follows: Anteriorly, a line beginning a little behind the vertex, passing downward behind the ear, without involving either concha or lobe, passing forward and encroaching upon the chin above the ramus of the jaw to a point about midway between lower lip and tip of chin, also slightly upon the cheek laterally. There were two distinctly tender areas about the size of a twenty-cent piece over each malar bone, corresponding to Head's maxillary zone. Below the ramus of the jaw the entire cervical region was involved anteriorly, as well as laterally and posteriorly. In front, the clavicle marked the lower boundary behind a line from acromial tip to acromial tip. Superficial tenderness was most marked in the cervical region anteriorly and laterally, at the ramus of the jaw, and on the occiput to somewhat above the external occipital protuberance. All areas were perfectly symmetrical. (Figs. 1 and 2.)

Operation.—In view of the existing focal symptoms, I made an incision over the area, and found that the anterior wound was non-penetrating, although the opening in the skin corresponded in size and contour to that of a 38-caliber revolver bullet. The posterior one was penetrating. On enlarging the opening in the bone, numerous chips of bone were found in a cavity about the size of a walnut. The cavity was filled with blackened brain detritus. The dura over the cavity was blackened and torn. Careful and gentle search within the cavity did not reveal the bullet. After removal of the bone fragments, the wound was irrigated with a normal salt solution, drained with iodoform gauze, and the skin incision closed with sutures up to the drain.

Fig. 1. D. Trautman, Hyperalgetic zones on admission. (Lateral view.)

Course.—November 17th. 5:30 A. M.: temperature 99.6°; pulse 64; respirations 22. 9:30: semi-conscious blood pressure—radial, right 10.5 cm., left 11.0 cm. Quite restless later in the day.

November 18th. Temperature (rectal) 100–101.4°; pulse 60 to 72. Patient conscious, but difficult to arouse. While dressing him, he asked not to touch his head or neck, but to allow him to assume the desired position himself. When asked why he wanted this done, he stated that the touching of the hand caused him great pain. Areas about the same. Tactile and temperature sense normal. A smear from the packing showed a few staphylococci.

November 19th. Temperature (rectal) 100–101.6°; pulse 66 to 72. Rational.

November 20th. Temperature (mouth) 99.4°–101.6°. Severe pain in right eye when looking at light; Both conjunctivæ reddened; watery discharge.

November 21st. Temperature (mouth) 100–101°. Rational. Pain in both eyes; reddening of conjunctivæ; irrigation with boric solution.

November 22d. Temperature 99. 2–1 02.2°. General convulsion lasting five minutes.

November 23d. Temperature 99.4–100.6°. Restless; pain in head; involuntaries; packing removed.

November 24th. Temperature 98.8–100°.

November 25th. Temperature 98.8–100°.

November 26th. Temperature 98.4–99.8°. Feels quite well. Sensitive areas about the same, but diminishing in intensity. Left-sided paralysis about the same.

November 30th. Temperature 99–99.4°. Sitting up in chair. Areas about the same.

December 1st. Temperafure 98.8–99°; pulse 74–78. Sitting up in chair. This continued without much change until December 8th. (Fig. 3.)

Examination.—Slight tenderness over the lower portion of the occiput, along the ramus of the jaw in the anterior and posterior cervical region to the level of the upper border of the cricoid cartilage. This band was about the most sensitive. Patient remarked that he noticed the tenderness at the ramus of the jaw when he washed himself. The two maxillary spots also showed slight tenderness still persisting.

Paralysis.—Facial considerably improved. Arm but slightly improved; reflexes increased. Leg slightly improved; reflexes increased.

Eyes.—Movements normal; eye-grounds normal; conjunctivæ clear. Temperature, tactile sensation, normal.

December 9th. Temperature 97.6–98.8°; pulse 60 to 68. Complains of severe pain in back of head.

December 10th to 16th. Temperature normal. General condition good. Areas of hyperalgesia about the same.

December 17th. Temperature 98.2–99.6°. Sitting up. Complains of pain in head.

December 18th. Temperature 99°.

Fig. 2. D. Trautman. Hyperalgetic zones on admission. (Front view.)

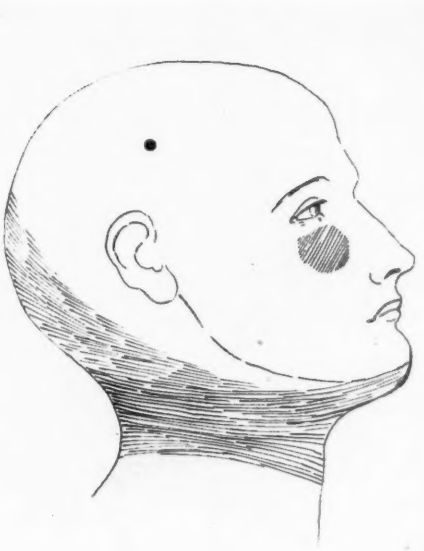


Fig. 3. D. Trautman. Hyperalgetic zones, Dec. 8, 1904.

December 19th. Temperature 98.2–99°. Pain in head. Area still marked at ramus of jaw. Other areas slightly present, as December 8th.

Dec. 20th. Temperature 98.8–99.4°; feeling quite well.

Dec. 21st. Temperature 98.6–99.4°; feeling quite well.

Dec. 22d. Temperature 99.0–99.8°; pulse 72 to 82; feeling quite well.

Dec. 23d. Temperature 98.6–99.2°; pulse 68 to 70. Felt quite well in the evening; complained of severe headache after dinner; had a general convulsion about 3:00 P. M., and died at 5:00 P. M.

Post-mortem.—Scar on scalp over right parietal region. Beneath scar a defect in bone about an inch in diameter, filled completely to the edge with firm granulation tissue of cartilaginous consistency. The area beneath, corresponding to the defect in the brain, was about 2½ cm. in diameter, involving the anterior central convolution mainly, a small portion of the pos erior central convolution, and a portion anterior to the anterior central convolution. The defect was about 4 cm. from the upper margin of the right lobe. On the mesial surface of the right lobe an abscess was found. This was about the size of a small walnut, and located a little above the splenium corporis callosi about opposite the præcuneus. It contained an irregular piece of lead representing about one half of a bullet. The distance of the point of entrance of the bullet into the brain substance from a point on the horizontal ramus of the Sylvian fissure in a straight line, about 6 cm. The most affected portion of the motor area was the middle third of the anterior central convolution. The area affected by the path of the bullet measured about 4 cm. longitudinally. The course of the bullet was from above, downward and inward. The abscess had ruptured into the right lateral ventricle. Frontal sections of the affected area showed no pus and no macroscopical changes. Base of brain entirely free; meninges free; left hemisphere negative; other organs negative.

With few modifications, the preceding case is identical with the five cases of Wilms (Fig 4.) and the one case of Milner. My case differs inasmuch as the hyperalgesia encroaches somewhat upon the face occupying these two zones, which Head designates as hyoid and mental zones respectively. The hyoid zone is incomplete in all the cases. It is most complete in my case, lacking but the area of the lobe of the ear. In the remainder of the cases only the small portion beneath the ramus of the jaw is present. The mental zone is not present in the other cases. Likewise, the maxillary zone is absent in the remainder. Fig. 5 shows the distribution of peripheral nerves in head and neck. The area involved is supplied by the great occipital nerve (posterior division, second cervical), the small occipital (anterior division, second cervical), auricularis magnus (second, third cervical, anterior division); superficialis colli, second and third cervical anterior division. The nerve-supply of the mental zone varies in some cases; it is supplied by the third branch of the trigeminus, in others by branches from the cervical plexus. The only area undoubtedly supplied by the trigeminus is the maxillary zone (V). The area of skin injury is above the territory of any of these nerves. Injury of peripheral nerves is excluded. Peripheral root zones overlap to a much greater extent. (Figs. 6, 7, 8, 9, Sherrington.) The areas involved in my case correspond well with

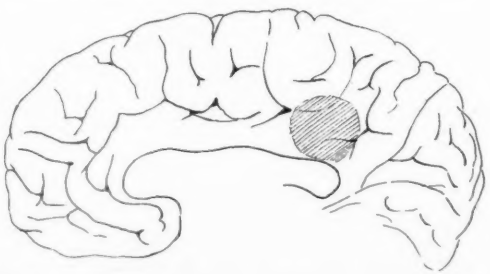


Fig. 4a. Location of abscess and bullet.

Fig. 4b. (Wilms 1.)

the second, third, and fourth cervical segments (Allen Starr). The arm area belonging to the fourth cervical segment was not involved in either case. The areas were entirely symmetrical. Central origin must be assumed. Wilms (6) formulates the following in explanation:

1. In all cases the pain is a pure hyperalgesia. Tactile and temperature sense is normal. In consequence, we have to deal with a pure pain sensation of central origin, causing intense pain without injury to peripheral nerve endings. Light touch or pressure of dressings increased pain markedly.

2. Pain was symmetrical. Intensity equal on both sides. Disappeared in equal time on both sides.

3. Upper limit of hyperalgetic zone corresponds regularly to border of sensory zone of trigeminus.

4. Pain area does not correspond with territories of peripheral nerves.

5. Extension farther downward in cases 3 and 4 than in 1 and 2. The lower area not so painful, pains disappearing in this zone in one to two days, leaving a zone proximally equal in all cases.

6. Concomitant cerebral disturbance, i. e., commotio, etc., not marked at first. One died in twelve hours; three recovered. Pains disappeared in eight to ten days.

In view of the observations made, it is safe to assume that the areas observed in these cases of gunshot of the head are identical with the zones observed by Head in visceral and intracranial diseases. They are based upon an irritation transmitted to the cord by the sympathetic fibers. Their close relation to the peripheral sensory fibers causes a central irritation, which, by an error of judgment (partially due, perhaps, to the less acute pain, perception existing in the cortex for sympathetic pain transmission), are referred to peripheral areas. Hopkins (8) observed the following in every case after extirpation of the superior and middle cervical sympathetic ganglia for epilepsy:

1. Congestion of conjuctivæ and face.
2. Ptosis.
3. Increased flow of nasal mucus.
4. Decrease in pulse and respiratory movements.
5. Voice husky.

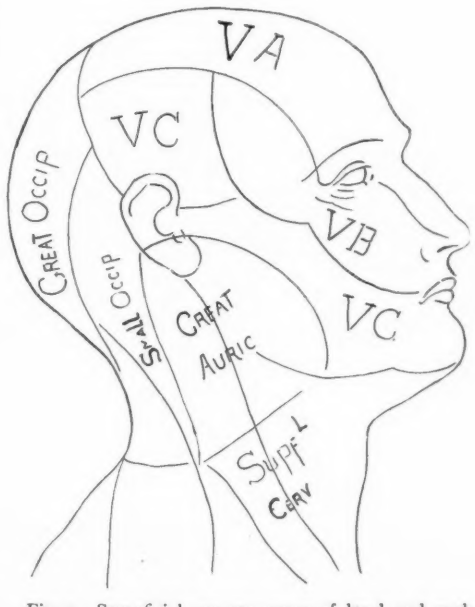
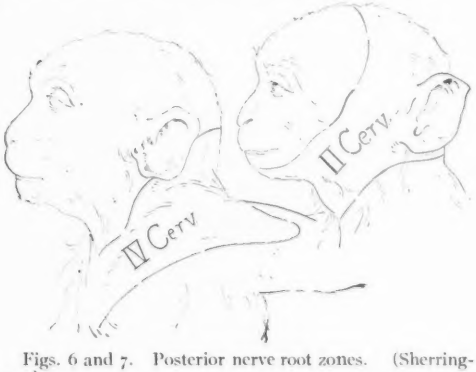


Fig. 5. Superficial sensory nerves of head and neck. (Thane.)

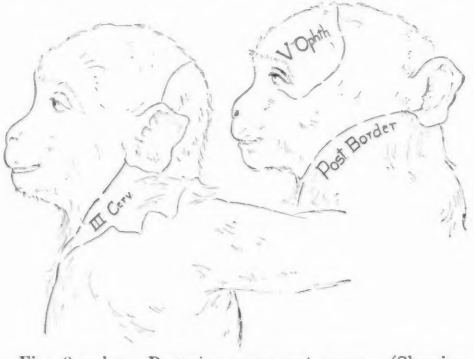
6. Complained of pain along the ramus of the lower jaw.

In this case paralytic and irritative symptoms are probably mixed. The pain at the jaw is undoubtedly a symptom of irritation, likewise the congestion of the conjunctivæ. The operator does not state how long these symptoms persisted. It is remarkable that the pain area is so small in so profound an irritation as the operation must produce; the similarity of the irritative symptoms is, however, apparent, adding proof that the areas are those of pain transmitted along sympathetic fibers and projected peripherally.

As to the explanation of the origin of hyperalgetic zones in gunshots of the head, the assumption that the center of sensation might give rise to such hyperalgesia is somewhat opposed to our present views. Brain substance is supposed to be void of all sensation. However, Monakow (9) states that "cerebral eccentric pains in certain portions of the body and in the face have been repeatedly observed and described in cortical tumors and in disease of the posterior portions of the optic thalamus." In case 2, Wilms found the bullet in the body of the sphenoid, a little in front of the Gasserian ganglion, below the carotid, and between the trochlear nerve and the ophthalmic branch of the trigeminus. This led him to belive that the hyperalgesia is due to injury of the cavernous plexus of the sympathetic nerve, thus producing the hyperalgetic areas in the manner mentioned above. In two of the cases the bullet lodged in the frontal lobe (lower portion). For these he assumes that the bullet took a downward course (due to some lowering of the revolver), struck the lateral portion of the sphenoid, and glancing off, was buried in the lower portion of the frontal lobe. He asserts that the location of the bullet does not indicate the end of the shot canal. Thus the existence of hyperalgetic areas might, to a certain extent, allow of judging the location of the bullet. In Milner's case the bullet was situated near the entrance wound. The probability of having touched the body of the sphenoid or its lateral margin is not very likely. In Wilms's fifth case the bullet traversed the lateral hemisphere (frontal and a portion of parietal lobe), and was found in the posterior cornu. Wilms then retracted his former assertion, and states that the phenomenon is due to injury of larger areas of frontal lobe when the sympathetic fibers follow large vessels, or in places where the pia is more abundantly supplied with sympathetic filaments.



Figs. 6 and 7. Posterior nerve root zones. (Sherrington.)



Figs. 8 and 9. Posterior nerve root zones. (Sherrington.)

The phenomenon has, so far, not been observed in any other traumatic head or brain injuries except in gunshots, and only in certain of these. Undoubtedly, a number of cases presenting hyperalgesias have been overlooked, as the pain was attributed to general causes and remained unobserved. Records in this direction are, then, perhaps of little value. I have, however, collected eleven cases from the records of Cook County Hospital during 1903 and 1904, with the following results: One of these was probably non-penetrating as far as dura and brain are concerned, as the bullet was

found wedged in the bone in the center of the forehead. Of the remaining ten cases, five were unconscious when brought to the hospital, probably escaping observation altogether. Five were conscious on admission. Only one of these presented symptoms of hyperalgesia. These cases present the following characteristics:

293817.—*Entrance wound:* Right temporal, at junction of temporal and malar. *Sensory symptoms*: No record.

289518.—*Entrance wound:* Right temporal, (Wound of exit left temporal.) *Sensory symptoms*: Racking pain in head and shoulders. Severe pain in neck. Irrigation of eyes. (No meningitis; recovery.)

297321.—*Entrance wound:* Upper and anterior portion of right mastoid. Bullet firmly imbedded against petrous portion of temporal bone. (Found at operation.) *Sensory symptoms:* No record. (Death.)

302226.—*Entrance wound:* Summit of head, a little to right of median line. *Sensory symptoms:* Numbness of left side. Left leg paralyzed. Developed meningitis on seventh day. (Exitus a few days later.)

302287.—*Entrance wound:* Left temporal rerion. *Sensory symptoms:* No record

Sixty per cent of the cases died within a comparatively short time after the injury; only one of these of a complicating meningitis, the remainder from the severity of the original lesion. Case 297321, with marked injury to the petrous portion of the temporal, presented no symptoms. Case 302226 presented only sensory paralytic symptoms. Had a depressed fracture, and many small pieces of lead were found at the operation. Case 289518 had evidently a penetrating wound of both frontal lobes. I found records regarding pain in the nurse's remarks only. They were recorded up to about six weeks after occurrence of injury. In case 293817, doubt might be felt as to marked cerebral injury. He presented edema of the eyeballs, loss of vision (perception to light retained) in both eyes, and a lesser degree of exophthalmos. Was discharged six weeks after injury; eyes in about the same condition. As to the part of the brain involved in the seven cases reported to have shown well-observed hyperalgetic areas, relations are as follows:

Frontal lobe, 4; frontal lobe traversed—lodged in sphenoid, 1; parietal lobe, portion of frontal, 1; unknown, 1.

Of the cases at Cook County Hospital, the only one that did, beyond doubt, involve the frontal lobe showed some crudely observed symptoms. The shots involving the base in the anterior and middle fossæ, where injury of sympathetic fibers could be reasonably expected, did not show even the mention of a pain sensation. The gunshot of the summit is the only one in which injury to the frontal or parietal lobes took place without mention of a pain symptom, except those of meningitis. Examination, on the other hand, of a number of skull fractures, contusions and lacerations of the brain, lacerations of the dura, for symptoms of this nature, proved futile.

Negative.—Three cases of rupture of middle meningeal artery. No laceration of dura. Skull fracture in 2; no fracture in 1.

Negative.—One case of depressed fracture of frontal bone, with laceration of dura and superficial destruction of frontal lobe on right side.

Negative.—One depressed fracture in occipitoparietal region, with marked contusion of occipital lobe on right side negative. (Dura torn.) Subpial ecchymosis.

Negative.—One depressed fracture of the occipital region, due to a blow with a poker, driving a button of bone about an inch into brain substance.

To state with absolute certainty, however, the absence of the phenomenon would be impossible, as disturbances of the mental state are far more frequent in head injuries due to other forces than in the gunshots of the head in civil life. The symptoms of concussion and contusion, and also compression, are so predominant in many cases that exact determination of existing tenderness is impossible.

CAUSE OF HYPERALGESIA

The segments involved are usually the second and third cervical, also the fourth and fifth, varying perhaps with the intensity of the lesion. In my case, the second, third, and fourth were involved. The explanation of Wilms that injury of the cavernous plexus produced the zones seems at present untenable, since three cases

have occurred where a lesion of the cavernous plexus can be positively excluded. Kocher states that increased intracranial pressure produces pain by tugging which the dura may suffer at its places of attachment at the Falx cerebri, the tentorium, etc., also when detached from the surface of the bone. He does not consider manifestations of pain as of uniform origin. Cocainization of the dura may remove pain symptoms which he attributes to irritation of the trigeminus. Again, he positively asserts that pain may be produced by irritation of the cortex. Head has found that superficial tenderness is present in cerebral affections, while deep tenderness and localized pain are characteristic of meningeal involvement. He also attributes the hyperalgesia to increased intracranial pressure. In my case the sphygmomanometer registered about normal pressure on the side of the lesion and a slight increase on the paralyzed side. Both figures were within normal limits, not indicating an increase in general intracranial pressure. Horsley and Kramer (cited by Kocher), in their experiments with gunshots (200 to 300 m. initial velocity), note an inspiratory spasm in shots through the hemisphere. Vagus symptoms were sometimes absent, sometimes present. This suggests possibility of cortical origin of the inspiratory spasm. Kocher (10) pronounces all the symptoms due to commotio cerebri. This does not correspond with the markedly decreased occurrence of unconsciousness noted in all our cases of gunshot. If present, it could only be of the most temporary character, and the absence of the hyperalgesia in cases of commotio associated with loss of consciousness extending over a long period of time, as noted in other head injuries, seems to speak against it. Extirpation of the Gasserian ganglion situated so near the cavernous sinus has not been associated with hyperalgesia of any kind. Among twenty cases which I observed in the literature I mentioned only the report of A. E. Halstead (11). In a detailed description of post-operative symptoms no hyperalgesia is recorded. The remainder of reports is also negative. Disturbances of the third, fourth, and sixth nerves are, however, comparatively frequent in these extirpations. No such symptoms have been observed in Wilms's case. In four cases of evulsion of the third branch of the trigeminus (W. E. Schroeder) at the foramen ovale no hyperalgesias were observed. Kocher, in his work, makes a plea for more localization at the expense of so-called general symptoms. He lays stress upon the acute observations of finer sensory and vasomotor symptoms, and wishes these to be drawn into the circle of localized symptoms. To assume that the brain substance itself, cortex, subcortical region, or basal ganglia might be the seat of origin of this phenomenon is a daring hypothesis, without much foundation. It is true that pain can be produced centrally. So far, this pain has been almost only analogous to motor lesions, namely, opposite the central lesion, and, according to Monakow, associated with motor lesions in the majority of cases. In no way has there been any resemblance to zones, even unilateral. Head assumes that the sensory impulses reach the center through the vago-glossopharyngeus. Gaskell (12) has stated that the vagus and glossopharyngeus represent the visceral branches of a group of nerves whose animal sensory fibers are to be found in the sensory portion of the trigeminus. In my case, two symmetrical areas, maxillary areas, were present. This territory is supplied by the fifth nerve (second branch).

The following regions of the brain were injured by the bullet:

Cortex—Precentral convolution; postcentral convolution; gyrus fornicatus.

Subcortical—Centrum semiovale; splenium corporis callosi.

The connection of these regions with the trigeminus is still unknown. Hosel (13) believes that he has found the termination of the trigeminus in the central convolutions, owing to degenerations found in a cyst of the posterior central convolution. General sensation was intact, and he believes, upon the strength of this, that pain of central origin is quite improbable. Bernhardt cites several cases of sensory disorders, consisting chiefly of paresthesias and anesthesias of distinctly crossed character. No pain sensation of any kind is mentioned. The foci of the lesions were all in the so-called psychomotor area comprising the following:

Lower portion of Broca's convolution.

Insular convolutions.

Lower one third of anterior central convolution.

Anterior upper surface of first temporal convolution.

Upper one third of both central convolutions.

Cortex of upper parietal lobe.

Edinger (15) reviews the question of the origin of pain, citing a case of embolic softening in the external nucleus of the left optic thalamus, affecting to a small degree some few fibers of the external capsule. Pain spontaneous and on pressure, or any other stimulus, was the most persistent symptom in this case. Motor paralytic symptoms were present, but soon improved. Tactile sense was normal. All the hyperesthesia was on the opposite side of the lesion. In conclusion, he states the following: "Direct contact of the sensory path with diseased tissue produced the hyperesthesia and the pain in the opposite half of the body. Review of the literature for similar cases yields but little. Hyperesthesia in diseases of this region is as rare as anesthesia is frequent."

Among 34 cases of posthemiplegic hemichorea collected by Raymond, he found 2 cases of similar nature. No autopsy performed.

Ballet (16) has observed only 3 cases of hyperesthesia (all in apoplexy with paralysis) among the great number analyzed. This collection contains traumatic lesions of brain and skull, but not a single gunshot. All the cases showed hyperesthesia on the side opposite the lesion. Strange to say, in these 3 cases the frontal lobe (ascending convolution) was affected. He comes to the conclusion that in these cases symptoms were due to indirect transfer of a stimulus into the sensory tract. It becomes evident, then, that these observations of hyperesthesia have nothing in commen with our cases of hyperalgesia. Head, in trying to explain the mechanism of the hyperalgesia, is at a loss to trace the connection between stimulus conducted along vago-glossopharyngeus to cortex, and the subsequent connection with zones in the cord.

Nimier (17), in his large work on gunshots of the head, does not give the matter of hyperalgesia any attention. The earliest case, probably, which I found in the literature, but was unable to obtain, is that of Greffier, who reported an injury of the frontal and parietal lobes with hyperesthesia of the chest wall.

Cortical stimulation of organs governed by the motor sympathetic has been well observed, and its existence proven by experiments. Monakow (loc. cit., p. 173) states the following: "Cortical irritation may affect, according to Franck, Bochefontaine (19), all vegetative nervous apparatus; i. e., ganglia of the sympathetic nervous system. The foci seem to be diffuse, and their arrangement differs from that of striped muscle. The existence of such foci, however, cannot be doubted." If similar centers exist for the sensory sympathetic, is merely a matter of conjecture, likewise how an impulse could be transmitted downward by centripetal fibers. Head, in trying to explain the mechanism of transmission of the stimulus by the vago-glossopharyngeus, is silent on this latter point.

SUMMARY

1. The areas of hyperalgesia observed in gunshots of the head are identical with those observed by Head: (*a*) By showing segmental arrangement; (*b*) By not corresponding with peripheral nerves or posterior root areas; (*c*) Tactile and temperature sense are normal; (*d*) Decreasing intensity.

2. Injury of the peripheral sympathetic (intracranial), either at the base of the brain or in the membranes, cannot at present be considered causative of the hyperalgesia.

(*a*) Three of the cases showed injuries remote from the base, and large sympathetic plexus.

(*b*) Removal of Gasserian ganglion (intracranial); evulsion of branches of ganglion, (extracranial) are not associated with hyperalgesia.

(*c*) Injuries of the dura in other than gunshot lesions do not present referred pain.

(*d*) Besides, fractures of the lighter type with recovery (when injury to sympathetic might be expected) have, so far, not shown hypera'getic zones.

3. The frontal lobes were affected in all cases observed.

4. Injuries of the frontal lobes not due to gunshot have not been associated with hyperalgesia.

5. The phenomenon has been observed in gunshots only (in traumatic cases).

Case 1	Wound	Mental Condition	Sensory Symptoms, Motor, etc.	Course, Termination, Treatment	X-ray	Focal, etc., Symptoms
Wilms 1. 26 years. Suicide. Revolver 7 mm.	Entrance *right temple*, 5 cm. from external palpebral angle, parallel with eyebrow.	Fully conscious; answers questions promptly.	Slight pain in frontal region. *Great* pain in region of both ears and below margin of inferior maxilla. In this zone, touching with blunt articles and C. H. pencil experienced as burning pains. Complains of dressing causing intense pain in ears and neck. Below line of marked pain skin somewhat more sensitive than that of rest of body. This area is well defined, also, as compared with chest. Tactile and temperature sense normal. Form of articles well recognized. No cerebral disturbances. Swallowing painful (attributed to pains caused by movement of skin over jaw). Pain persisted for three days in uniform intensity; after one week indistinctly felt. Disappeared entirely after 12 days.	Excision of wound. Suture. Pulse slow, regular.	X-Ray. Bullet in lower portion of frontal lobe.	

Case 2	Wound	Mental Condition	Sensory Symptoms	Treatment—Course	Post-mortem	Focal, etc., Symptoms
Wilms 2. Locksmith, age 36. Suicidal. Entered hospital 1 hour afterward. Revolver 7 mm.	Right temporal region Same as Wilms 1.	Claims not to have lost consciousness. Fully conscious when received. Answers questions slowly. Wants to sleep; feels tired.	Intense pain on palpation, over both sides of neck. Hyperalgesia parallel to lower border of inferior maxilla to ear. Lower part of ear especially sensitive. Occiput also sensitive (not outlined definitely, on account of patient's condition). Lower border of zone parallel with cricoid cartilage. Below this line sensation somewhat increased. Hyperalgesia symmetrical. It seems as if hyperalgesia is a little more marked on left than on right side.	Treatment not given. Exitus twelve hours afterwards, after partial coma of several hours.	Bullet in body of sphenoid a little in front of ganglion Gasserii below carotis int. and between trochlear nerve and ophthalmic branch of Vth.	Right pupil larger than left. Slow reaction to light.

Case 3	Wound	Mental Condition	Sensory Symptoms	Treatment—Course	X-ray	Focal Symptoms
Wilms 3. Laborer. 35 years old.	4 shots, head, chest. One anterior, in frontal region. No bone lesion located under skin. *One right temporal* region wound perforating. X-rayshowed bullet in lower portion of frontal lobe.	Not unconscious. Received 14 hours after injury.	Marked hyperalgesia in neck, occiput, postcervical region. Even slightest touch causes it. Pains felt in area without touching it. *Course:* From chin, above upper margin of inferior maxilla in front of ear, to border between vertex and occiput. Zone of marked hyperalgesia stops at junction between neck and thorax. Here a zone of less sensation begins. Line in front to jugulum behind to hair border. Less painful zone is concentric about 10–15 cm. from lower border of markedly painful area across chest and posterior cervical region. Lower zone disappeared after three days, upper zone in nine days. After five days, zone still well marked. Tactile, temperature sense normal.	Not recorded.	X-ray. Bullet in lower portion of frontal lobe.	

Case 4	Wound	Mental State	Sensory Symptoms	Treatment—Termination	Post-mortem X-ray	Focal, etc., Symptoms
Wilms 4. Laborer, 21 years. Suicidal.	Frontal region to right of median line.	Not expressly stated, but complained of pain.	On entrance, complained of great pain at both sides of neck—occiput and postcervical region. Upper border corresponds with case 1. It starts at mental spine, follows lower margin of lower jaw, crosses ear above external meatus, and ascends to point between vertex and occiput. Lower border (like case 3) on chest a handbreadth above nipples; leaves shoulder free, crosses cervical region about first dorsal vertebra. Disappeared after a wieek. Lower border shifted upwards during first few days.	Dismissed cured.	Bullet not located.	No cerebral disturbance

Case 5	Wound	Mental State	Sensory Symptoms	Treatment—Course	X-ray	Focal, etc., Symptoms
Milner 1. J. B., 22 years. Suicidal. Revolver.	*Entrance.* 4 finger-breadths above a line between outer canthus and right external meatus Moderate hemmorrhage. No powder in vicinity. No cerebral substance discharging.	No loss of consciousness.	Violent pains in back of head and neck. Anterior upper portion of thorax elicited by palpation. No headache while resting. *Boundary—Anterior: Neck*—Left, little lower: right to clavicle. *Posterior*—To upper border of trapezius; on left, inner end of spine or scalpula. *Upper Boundary*—Parallel with lower jaw, crossing external ear over lobule, from there to apex of lambdoid suture. Pains on palpation not always equally violent. Pains at times by touching remote part, as patella, forehead, on quick passive motion of arm. Caused by jarring of bed. Dorsal position, if maintained for some time, causes pain in occipital region. Active motion of head not associated with pain. Pain at times in pharynx, with involuntary deglutitional motion, associated with annoying sensation in back of neck and occiput. No pain on swallowing. Loud noises cause pain in occiput and vertex. *Fourteenth day*—Hyperalgesia much decreased. Occurred in ntervals with varying intensity. *Most marked*—Left side of neck, two fingers below angle of jaw. Left lambdoid suture about middle. Right lambdoid suture not so often. These three places patient seems to locate fairly positive. Entire occiput more or less tender. No hyperalgesia on right side of neck. Discharged twenty-first day. No headache; occiput vertex sensitiveto ; palpation; also place below angle of left jaw.	Alcoholic odor of breath. No vomiting. *Second day:* Vomited twice; some pains. *Third day:* Pains intermittent; occur especially on palpation; temperature normal. Patient up on fourteenth day; no vertigo; no headache. Discharged twenty-first-day.	X-ray. Bullet near entrance wound, a little higher, probably in uppermost cerebral region (frontal lobe).	No paralysis. Conjunctivæ markedly reddened. No hemorrhage. Pupils medium size. Sluggish reaction. No paralysis of moto muscles. Skin, diffuse reddening. *Fourteenth day:* Psychical motor symptoms absent.

Case 6	Wound	Mental State	Sensory Symptoms	Treatment—Course	Post-mortem	Focal, etc., Symptoms
Wilms 5. Man 57 years. Suicidal. Revolver 7 mm., pointed toward center of forehead.	At glabella, to right of median line on) a vertical bisecting forehead.	Patient not unconscious.	Upper border of hyperalgesia follows border of inferior maxilla, passes over lobe of ear to point midway between vertex and occiput; lower border parallel with clavicle on both sides. Lower zone disappeared after third or fourth day. Sensorium affected after fifth day. From tenth day on, fever and symptoms of meningitis. Painful zone present as long as patient reacted.	Developed meningitis. Seropurulent flund issued from wound. Increasing somnolence. Exitus sixteenth day.	Sinuscavernosus and vicinity not injured. Bullet traversed anterior pol of right frontal lobe to right lateral ventricle. In consequence, cerebrum injured up to anterior portion of anterior cornu of right lateral ventricle. Bullet free in posterior cornu. Injury at anterior pol of frontal lobe in involved area of the size of a dollar. Canal itself began about 1-1½ cm. from surface.	

INDEFINITE CASES

	Wound	Mental State	Sensory Symptoms	Treatment—Course	X-ray Post-mortem	Focal, etc., Symptoms
Case 1. *Brodnitz (Verh. d. deutschen Gesell. für Chirurgie.* 32ter Cong., 1903). Occurred 1901. Suicidal attempt.	Left frontal region.	Fully conscious.	Extensive hyperalgesia on same side of neck. Line followed lower jaw, stopped in median line, extending downward to about cricoid cartilage; posteriorly to posterior border of sternocleido mastoid. Patient complained of pain in this region when brought in. Sensory symptoms disappeared after one week.	No indication for interference when brought in; 48 hours later, symptoms of intracranial pressure; pulse 48; vomiting; great restlessness. *Operation:* Bullet perforated anterior wall of frontal sinus; posterior wall shattered; bullet found right behind this, surrounded by destroyed brain substance. Removed without difficulty. Recovery.		
Case 2. *H. Schlosser (Bruns' Beiträge z. Klinischen Chirurgie,* 1898, vol. xxii.	Right temporal; left temporal; frontal.	Not given.	Left side of neck to supraclavicular region very tender. Tenderness in neck disappeared in a week. Tenderness in occipital region present.	Left bullet, superficial, removed from bone.	Bullet found at base of right frontal lobe; blood extravasation in corpus striatum; optic thalamus; right frontal parietal, and anterior portions of right temporal lobe.	
Case 3 *Milner (Berliner Klinische Wochenschrift).* Revolver. Right temporal region.	Right temporal region. Bullet penetrated both hemispheres; lodged in region of left central convolution.	Moderate somnolence, disappearing after two weeks.	Upper part of chest to middle of sternum; neck to margin of jaw; hairy head; hot in face. These were still present on eighteenth day.			Moderate right hemiparesis; no meningeal symptoms; no choked disc.
Case 4. Revolver.	Both frontal lobes.		Hyperasthesia of chest, neck, and head present when patient first seen. Not quite disappeared after six weeks.	Suffered for a few days with symptoms of serous meningitis.		Marked double choked disc.

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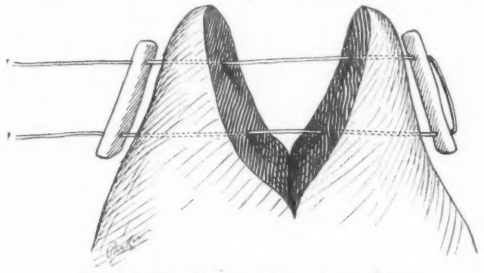
CARTILAGE PLATES FROM THE SCAPULA OF THE CALF FOR LIVER AND SPLEEN SUTURE

By M. STAMM, FREMONT, OHIO

Drs. E. Payr and A. Martina give an entensive report in *Archiv. für Klin. Chirurgie*, band 77, heft 4, on their experimental and clinical work in resection of the liver and their suture with magnesium plates. Their work is of such great practical value, that I think all those who do some work in that line, and are sufficiently acquainted with the



Representing the application of the plates.

German language, will study that article with special interest. Different plates, such as whalebone, ivory, turnips, potatoes, and decalcified bone plates, have been tried before this, but Payr and Martina claim that their magnesium plates have some advantage over all the others. Their method is certainly an ingenious one, and seems to fulfill the purpose admirably.

About 16 years ago (*Medical News*, Jan. 10, 1891), when Senn introduced his decalcified bone plates into intestinal surgery, I derived my plates from the cartilaginous portion of the shoulder-blade of the calf, thinking that they presented the advantage that they can be made at a moment's notice, without any lengthy process of decalcification. I have also procured from the same source chips to fill bone cavities, and used them in several cases with great satisfaction where strict asepsis could be maintained. So far I have tried this method of liver suture only on the dog, and with such satisfaction that I do not hesitate to publish the result at once, in order to incite others, who have better opportunities than I have, to give it further experimental and clinical test. I removed from a large dog a piece of the right lobe of the liver, about 2 inches long and 1½ inches wide, through the whole thickness of the liver.

The plates were of about the thickness of solid pasteboard and two holes were punched into each one. For suture I used Mayo's large needle (sharp) and No. 2 dry sterilized catgut. It may be better to use a blunt, straight needle, but I saw no bad effect from the sharp needle. After about sixty hours the dog had recovered so far that he was in a playful mood and tried to jump up on me. Two weeks later he was killed, the seat of resection was covered with adherent omentum, plates were fully absorbed, and some solid cicatricial tissue marked the place of resection on the convex side of the liver; no mark was left on the concave side and no sign of adhesion on the part of stomach and bowels. All I claim for the cartilage plates is that they can be readily procured, and seem to do the work as efficiently as any other material; they, also, can be cut in any shape desired.

THE ANTISEPTIC ACTION OF BROMINE, WITH DESCRIPTIONS AND ILLUSTRATIONS OF CASES

By DR. H. E. STROUD

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IT is now generally known that surgery has made greater advancement in the last two decades than all other branches of the healing art combined. The reason for this is obvious. We can see what we are doing. The microscope and the study of bacteriology have cleared the way.

But the description of hospitals prior to Lister is nothing less than shocking. Hospital gangrene and puerperal septicemia infected every ward. Pus was expected in every wound and incision. And the now nearly obsolete term, "laudable pus," is about all that remains of that period.

The methods of Lister were quickly instituted all over the world, and although the carbolic-acid spray and carbolated dressings were soon found to be unnecessary, the general cleaning up of hospitals that resulted from this great man's teachings vie with vaccination and antitoxin as life-saving measures.

It is a just criticism that the medical profession goes in areas; that we make a fad of something, and later drop it for something else. There is no doubt that antiseptics were used to excess, as, for instance, bichloride of mercury in the abdominal cavity; but, following the antiseptic period came the aseptic period, in which antiseptics of all kinds were neglected, even in septic cases, but we are now in a period where general principles and no set rules control out treatment. If all our surgical cases were aseptic, we should have but little use for antiseptics, but infected wounds will always occur, and I wish to set forth the value of bromine as an antiseptic of the highest order.

The mode of use is this: Bromine 2 drams, bromide of potash 2 drams, and one pint of water; mix, and keep in glass-stoppered bottles. The part to be treated is cleaned as well as possible and wrapped in a single thickness of plain gauze, and over this is applied a thick layer of absorbent cotton. Into a glass jar I put from 6 to 20 gauze sponges of ordinary size, and pour over these as much bromine solution as they will take up, squeezing out the excess. The glass should be very closely covered, as the fumes of the bromine are very irritating. With a pair of forceps I quickly lay these pledgets on the cotton, and instantly cover with a thick layer of cotton, and also instantly wind the whole part up in oiled silk, and bandage very loosely. We now have pledgets of gauze soaked in bromine solution between two layers of cotton, and the whole is made air-tight with the oiled silk. The result is that the fumes of the bromine, but not the solution, are brought in direct and constant contact with the diseased part. This dressing may be renewed from 6 to 24 hours. In very severe cases of infection I inject a few drops of the solution, but ordinarily reduce it 1 to 10 with water, and use this solution to syringe pus cavities and gangrenous patches.

Figs. 1 and 2 are of a boy aged 14, who ran a nail in in his foot on July 1st. Pain and swelling began that night. He hid his sufferings, as he wanted to go to the Fourth of July celebrations. On July 5th a physician was summoned, who advised a simple lotion and to keep the foot elevated. On July 10th I was summoned, and Figs. 1 and 2 will show the condition I found. On the

Fig. 1. Photographed July 10, 1905.

dorsom of the foot, also on the sole, were large blebs filled with greenish, brownish, vile-smelling fluid Patches of gangrene and mold were numerous. The line of demarkation is plainly seen. The foot was cold, although the boy's temperature at 9 A. M. was 104½° and pulse 143. A red line ran from the ankle to the groin, where a swelling as large as an orange had formed. The child had been delirious for two days, and wildly so at night.

I thought this was indeed a case to demonstrate the value of bromine, and the only thing I did was to open the blebs and wipe away some of the secretion; and while I was having the bromine solutione prepared the photographs were taken.

The foot was done up as previously described, but a large quantity, nearly 8 ounces, of the bromine solution was incased inside of the oiled silk. The dressing was well carried up above the line of demarkation, and the dressing was repeated at 3 and 9 P. M., and at 9 A. M. the following morning, when severe pain and burning were caused by the fumes of the bromin, and at each dressing the quantity of the bromin had to be reduced. The discharge was enormous. Immense sloughs became loose and fell out. After the fourth day the foot was washed with iodine water, as suggested by Dr. Nicholas Senn in his most valuable article on iodine, which appeared in the first issue of SURGERY, GYNECOLOGY AND OBSTETRICS. Free discharge was easily secured, as all of the thick skin of the sole of the foot fell off.

After the seventh day the bromine treatment was suspended. Everything about the foot was perfectly healthy.

Fig. 3 shows but imperfectly where a very large slough was removed near the heel. This had partially filled with granulations before the photograph was made. In three days after the bromine solution was used, the red line and the indurated gland in the groin had absolutely disappeared. The internal treatment in this case consisted of small doses of phenacetine and caffeine, to reduce the excessive temperature, and nearly constant sponging was used for many hours to reduce the fever. Ten grains of calomel were given at one dose, followed in three hours with oil and salts, to secure free catharcis. Bicarbonate of soda was given several times in the day, to prevent salivation, and after the bowels had moved thoroughly, tincture of iron and quinine were given in full doses.

Fig. 2. Photographed July 10, 1905.

On July 17th there was no fever. The boy felt well enough to get up, and the only medicine used from that time on was elixir of lactopeptine, with iron, quinine, and strychnine. From this day on the foot was dressed with a plain ointment, vaseline with a little boric acid. Each day the foot was washed with iodine water, and

the boy's mother took charge of the dressing from that day on

Fig. 4 shows how slight a scar and deformity resulted.

I know of no other treatment where such results could have been obtained. Those of my *confrères* who saw the case prognosticated

Fig. 5. Photographed July 17, 1905. Imperfectly showing where a large slough was removed near the heel. Tissues healthy and rapidly granulating. The bromine was discontinued.

the loss of the foot or life, or both. The happy issue I ascribe entirely to the penetrating and powerful germicidal action of bromine.

I will here interpose a caution in regard to its use. The fumes are most irritating and suffocating. It is best to remove the patient out of doors, if the weather permit, when putting on the dressing. If this is impossible, the pledgets soaked in bromine should be applied with great rapidity and the part wrapped in cotton and then enveloped in oiled silk quickly.

In several cases where I have used this on the face or neck, I have closed the nose with a patent clothes-pin and had the person breathe through a tin trumpet or tube, which any tinner can make in five minutes.

I have not used a knife on a carbuncle for years. The curved incision, with its loss of blood and long period of healing, has no charms for me. The following case will illustrate a method that, so far, has given a hundred per cent of cures.

Some years ago when visiting a small hospital in a lumber-camp, the surgeon in charge asked me to see what he said was the largest carbuncle on earth. It extended from the top of the head to a point below the scapula. A thin, glairy discharge was pouring out of hundreds of openings. It was indeed a veritable ant-hill. The patient belonged to the lower strata of humanity. He had only just come into the hospital, and the carbuncle had been poulticed, if I remember right, for several weeks with cow-dung. He was practically in a state of collapse. It was very difficult to detect the pulse, and for six or seven hours we worked incessantly to revive him sufficiently to bear an operation.

Fig. 4. Photographed September 1, 1905. The boy had been wearing his shoe since August 23d.

About half an hour before operating a quarter of a grain of morphine and a sixtieth of atropia were given hypodermically, with the belief that morphia in such cases is a heart-stimulant, and removing the fear, and reduce the quantity of anesthesia needed. Ether was very cautiously given. The thermo-cautery was heated to a dull red and each of the hundreds of holes was perforated and thoroughly burned out. For over an hour this burning was cautiously continued until all the swelling and enlargement in the region of the neck was thoroughly burned away and a loose flap of skin with the

numerous holes alone remained. One dressing of the bromine, as previously described, was used. But the greatest care was used to see that the patient inhaled none of the fumes of the bromin. Every means known to the medical art was required to keep alive the spark of life, but in four days he was dressed and out of doors, and complete recovery was rapid. The points to be remembered in the use of the thermo-cautery are, not to have the tip too hot and to burn slowly.

It seems unnecessary to specify the many conditions in which a powerful germicide may be used with advantage. Some shin ulcers are most offensive, due to the presence of bacteria. Nothing I have ever used has removed this fetor like bromine, and after this the ulcers have seemed to yield to the regular treatment much more rapidly. One of the most intense infections I ever saw was that of a shepherd who had run a thorn in his knee and tried to extract it with some tweezers he used to pull maggots out of his sheep. The course of the infection was cut short in a few hours by bromine, used as above described.

THE INJECTION OF AIR INTO THE CIRCULATORY SYSTEM OF ANIMALS[1]

By EZRA READ LARNED, M. D., CHICAGO, ILLINOIS

UNLESS I am much mistaken, most practitioners of medicine believe that the accidental injection of even a small bubble of air will be followed by very serious consequences. The technic of many operations is modified because of this superstition, and the simple operation of administering medicine subcutaneously by means of a hypodermic syringe is looked upon as a serious matter, and students and nurses are cautioned to see to it that all air is excluded from the needle before it is allowed to penetrate the skin of the patient, to obviate the great danger of the injection of air into a vein accidentally. That medical practitioners believe in the verity of this danger is not to be wondered at when standard medical books are consulted. Most of the older books teach this idea. The beneficent results of antidiphtheritic and certain other sera have been modified, owing to a few cases of sudden death, soon after such administration, being charged to air embolism.

Rose and Carliss's *Manual of Surgery*, 6th, rev. ed., 1905, on page 289, says the entrance of air into veins, though rarely met with, is fraught with the utmost danger to the patient. The air becomes churned up in the cavities of the right side of the heart, forming a spumous, frothy mixture amongst the columnæ carnæ, which the heart can only with difficulty eject; thus the circulation is brought to a standstill in spite of forcible contractions, and the patient dies from anemia of the lungs and brain.

On page 76, referring to injuries of the intracranial blood-vessels, the statement is made that the entrance of air has led to a fatal issue in a few cases.

In the *International Text-book of Surgery*, ed. 1903, vol. i, p. 898, in the chapter referring to injuries of blood-vessels, are several paragraphs with regard to air embolism, and the statement is made that the entrance of air into the circulation, aside from where it enters the uterine sinuses, occurs exclusively after injuries to the veins, especially those of the base of the neck. It states that the air rushes in with a peculiar hissing sound, and if in sufficient quantities, death is almost instantaneous. Single small bubbles of air are not necessarily fatal. Death is due to the air collecting in the right side of the heart and preventing the contraction of the right ventricle, which finally stops the heart in diastole.

In Von Esmarch's *Surgical Technique*, ed. 1903, p. 649, referring to operations for cervical tumors, occurs the statement that injuries to veins are almost the principal danger, partly on account of violent hemorrhage, partly on account of the possibility of air entering the veins, accidents that may cause instant death, air embolism, and cardiac insufficiency.

On the other hand, Von Bergmann's *System*

[1] Read at the meeting of the Chicago Medical Society, October 25, 1905.

of Practical Surgery, ed. 1904, vol. ii of the English translation, on page 55, chapter on injuries of veins in the neck, says wounds in the neck are life-endangering accidents, owing to hemorrhage and the possibility of air entering the veins. On this page and on the succeeding pages is a description of the symptoms accompanying the entrance of air into veins, as follows: In the majority of cases the entrance of air is accompanied by an intermittent hissing or gurgling sound. At the same time, or a few minutes afterwards, symptoms referable to the heart and the breathing appear. The patient turns pale, has an anxious expression, or screams, the breathing becomes more difficult, the pulse weak, frequent, and irregular, pupils are distended and do not react, consciousness is lost, convulsions and death closing the scene. Statistics collected in 1864, of 64 cases, show that 24 died instantly or within a short time, that 27 recovered after showing alarming symptoms, and in 9 no influence on the general condition was observed. This authority admits that this result is not the rule. The symptoms subsided in a portion of the cases, and complete recovery may take place even if the symptoms have been severe. Von Bergmann further states that this accident, formerly so dreaded, seems to have become less frequent in late years, and gives as a reason, the improvement in technic and improvement in operative conditions, such as complete anesthesia. Reference is made to animal experiments, but with the qualifying statement that conclusions arrived at were not uniform.

In the *American Text-book of Physiology*, p. 389, in the chapter on circulation, reference is made to the danger of entrance of air into a wounded vein, accidents commonly followed by immediate death, for reasons not here to be discussed. Farther on, it states that when air is thrown into a vein, the blood and air enter the heart together, possibly with deleterious effect.

In the *American Text-book of Surgery*, ed. 1899, p. 1072, is a reference to air embolism, in which the statement is made that it is a danger to be avoided, and that death is the not infrequent result. It speaks of numbers of experiments having been made to determine the cause of death, and that the conclusion of the experimenters is that the air finds its way into the right side of the heart, and being elastic, the right ventricle cannot empty itself, and the result is anemia of the brain, followed by syncope and death.

Malcolm Goodridge, *American Journal of the Medical Sciences*, states, in a paper discussing this subject, that entrance of air into the veins, even in small amounts, is to be dreaded, as it may result in death. He states that any teaching to the contrary is pernicious and not supported by facts.

Let us see whether they are or are not supported by facts.

Personally, I believe these conclusions are entirely unjustifiable, and that air embolism is not necessarily fatal, or even attended with grave results, and that teaching to the contrary is unwarranted and not based upon facts. In the manufacture of antidiphtheritic serum, it occasionally happens that a horse is paralyzed from the influence of the diphtheria toxin. In such cases it has been our custom to kill these horses with chloroform. Three horses so paralyzed were used as subjects for experimental air embolism.

Experiment 1.— In this horse, 20 c.c. of air were injected into the jugular vein; after five minutes, a second injection of 20 c.c. without effect; after another five minutes, 40 c.c. injected without effect; after another five minutes, or twenty minutes after the first injection, we injected 160 c.c. into the jugular vein.

The only symptoms we could discover were mere labored breathing, which, after a time, passed away, leaving no effects whatever.

Experiment 2.— Horse. 300 c.c. of air were injected promptly into the jugular vein. After one minute there was quickened respiration, with spasmodic contractions of the muscles; after four minutes, hiccoughs, which lasted ten minutes; after fifteen minutes, uneasy but slower respirations, with an occasional hiccough. Two hours later the horse had entirely recovered. Several hours after this, we injected 600 c.c. into the jugular vein of this horse. After one minute there was spasmodic respiration; the horse acted as if it were choking. There was profuse perspiration. The temperature fell 0.4°. After ten minutes the symptoms had entirely disappeared, and the horse was as be-

fore; fifteen minutes later, we injected 1,200 c.c. of air. The horse was quiet. Breathing almost stopped. Later, the breathing had stopped for ten seconds, then continued normal for a few minutes. After waiting a half-hour, and no further symptoms at all, the animal was dispatched with chloroform.

Experiment 3. — Horse. In this experiment we made the attempt to kill the hores by the injection of air into the veins in the following way. A 2,000 c.c. graduate was arranged in the form of a Spritz bottle; i. e., a large rubber stopper was placed in the mouth of the graduate, with two glass tubes leading into the graduate through the stopper. To one of these tubes was attached an ordinary rubber bulb; to the other a piece of rubber tubing, armed at its distal end with a veterinary hypodermic needle. Between the needle and the glass tube was a screw-clamp, which prevented air from passing from the graduate through the needle until the desired moment. We first pumped as much air into the graduate as was possible by squeezing the bulb, calculating that the pressure was something over twenty-five pounds to the square inch. This would mean that the graduate contained several times more air than it would under ordinary atmospheric pressure. The needle was then pushed into the jugular vein of the horse, the clamp released as quickly as possible, and the compressed air in the graduate allowed to rush into the vein. Very soon the animal showed symptoms of dyspnea, staggered, showed some hiccough, but after several minutes presented practically the same appearance as before the air was injected. We were surprised that this extraordinarily large volume of air, forced under pressure into the circulation, should not have killed the animal. In order to determine whether or not this was possible, the animal was finally dispatched by pumping air into the veins for a considerable length of time. The detailed notes of this experiment were unavoidably lost, so that we do not know exactly how long the air was pumped into the veins before the animal died, but it was certainly a very long time. It seems to me that this test demonstrates that a very large volume of air—in this instance it was several liters—may be injected into the jugular vein without producing death, but it is, of course, possible to produce death in a horse by deliberately injecting exceedingly large quantities of air. On the other hand, please consider that it frequently happens in the injecting and bleeding of horses used for the production of serums, that quantities of air enter the circulatory systems of these animals without producing any deleterious results whatever. This is such a common occurrence, that we have come to look upon the question of air embolism, that has been so frequently claimed to have been produced by accidental injection of air into the circulatory system during operations on the veins, as being decidedly far-fetched, to say the least.

Experiment 4. — Dog, weighing about 20 pounds. The jugular vein was laid bare, and, using a 20 c.c. syringe, we injected sixteen of these syringefuls, one after the other, or a total of 320 c.c. of air. After one minute, labored breathing set in. In fact, the symptoms were practically the same as in the horse, dyspnea. Two minutes after the injections were stopped, the animal recovered, and the normal breathing was re-established. Allowing the dog to rest for one hour, the injections were repeated as before, with practically the same results.

Experiment 5. — Rooster. A small bubble of air was injected into the veins. No apparent effect. Then 1 c.c. was injected. The patient became somewhat dyspneic, acted as a chicken does that has run rapidly for some distance, gasped for air a few times, then recovered entirely.

Experiment 6. — A guinea-pig, of standard weight. Small bubble of air injected into the jugular vein. After three minutes, 1 c.c. was injected, quickened respiration being apparently the only effect. Animal recovered entirely. These experiments we repeated on other animals, with identical results in every case, with one exception.

Experiment 7. — A small rabbit, weighing 2 pounds, was taken, into whose jugular vein we injected 20 c.c. of air as quickly as possible. Decided effect at once; quickened respiration, spasmodic contraction of the muscles. After two minutes, the respiration became less and less frequent, stopping three and three fourths minutes after the commencement of the experiment in the death of the animal. Bear

in mind that in this small rabbit we injected 20 c.c. of air instantly, and that a corresponding amount for a forty-pound child would be 400 c.c

Conclusions.—In conducting the seven experiments I referred to, one is strongly impressed by the similarity of the effects observed to those of dyspnea. The air entered the heart and remained there as an air embolus, as some one called it, stopped the circulation, or it passed the heart and formed air emboli in the branches of the pulmonary artery, thus, for the time being, shutting the blood off from that part of the lung supplied by that particular vessel, and the animal becomes dyspneic. It is easy to see that if *enough air* is injected, the circulation in the lungs may be so nearly stopped as to cause death, but one or a few bubbles of air will merely temporarily close a few of the branches of the pulmonary artery. This would be absorbed by the blood in a very short time, especially as it is in contact with venous blood under arterial pressure. In ordinary hypodermic medication or the injection of sera, I believe the danger from air embolism is absolutely nothing. In our laboratory, in the past ten years, we have made literally thousands and thousands of such injections into rabbits, guinea-pigs, rats, mice, dogs, horses, and other animals, and have yet to see any harm come from them. If you must have a name for the cause of sudden death following the injection of serum, why not acknowledge our ignorance in the matter and call it "shock?"

Pirogoff, as well as Laborde and Muron, has slowly injected large quantities of air into the external jugular vein of animals with impunity, and death took place only when from 100 to 200 grams of air were injected rapidly.

Uterhart came to the conclusion that large quantities of air—300 grams—could be injected without damage into veins situated some distance from the heart.

Chaveau was able to introduce large quantities of air into horses without particular effect. Binay and Couty found that up to 100 grams of air could be injected into dogs at one time, or in small quantities at intervals, without fatal effect.

I think that the recitation of these experiments, reinforced by the reports of Senn and Hare, show that even a large air embolism is not nearly so dangerous as a small air embolus has been thought to be, and as has been taught: that the danger of air embolism is slight. Since massive injections in horses and dogs are not necessarily fatal, there is no reason for asserting that minute air emboli in man are deadly, although it is possible that large quantities of air, such as 800 or 900 c.c. would produce disastrous effects if it could find entrance to the jugular vein of a man.

Now, referring to Nicholas Senn's *Experimental Surgery*, and his remarks therein on air embolism. (The classical experiments of Senn are the most exhaustive, carefully conducted, scientific experiments of which we have any published account.) The following brief abstracts are made from this work.

Experiment 1.—Dog, weight 65 pounds. Injected 30 c.c. of air into the left jugular vein. Churning sounds over cardiac region loud and distinct. Heart's action became very tumultous and intermittent. Respirations superficial and labored. The animal was bled from the distal end of the jugular vein to the amount of four ounces, whereupon the heart's action became regular and the respirations diminished in frequency. The vein was divided completely and both ends tied with fine catgut ligatures, the wound being closed in the usual manner. For a number of days the dog appeared quite unwell, showed no disposition to eat, and acted very stupidly, being inclined to sleep most of the time. Subsequently he recovered completely. In this case the intravascular pressure was promptly relieved by free bleeding, which enabled the heart to force the air through the pulmonary into the general circulation. The stupid condition of the animal was undoubtedly due to embolism of the cerebral veins, which disappeared after the disappearance of the air emboli by absorption.

Experiment 2.—Dog, weight 35 pounds. Before the operation, respirations 40, pulse 140. Injected 20 c.c. of air into the right jugular vein. Convulsions followed, which lasted for about two minutes. Respirations rapid and stertorous. Pulse 300. After five minutes the animal made repeated attempts to get up and walk, but invariably fell down, on account of imperfect control of the movements, or par-

alysis of the posterior extremities. About an hour later, the animal was able to walk, but appeared very feeble. Pulse 124; respirations, somewhat accelerated. Recovery was complete. In this case, the equilibrium of the circulation was soon restored, and the air in the right side of the heart forced through the pulmonary into the general circulation in a very short time, as was evident from the presence of symptoms indicative of embolism of some of the veins in the cerebrospinal centers.

Experiment 3. — Dog, weight 75 pounds. Injected 60 c.c. of air into the right jugular vein. Churning sounds loud and distinct. Heart's action labored. Respirations exceedingly rapid, later stertorous. The animal recovered rapidly from the immediate effects of the air embolism and was soon as well as before the operation.

In these experiments you will note that all the animals recovered after large injections of air into the circulatory systems. In some of Senn's experiments the animals died, as, for instance,—

Experiment 4.— Sheep, weighing 125 pounds. Left jugular vein. The vessel was opened in its lower third, but no air entered. A rubber tube was introduced for a distance of two inches, with a view to facilitating the spontaneous ingress of air, but this accident failed to occur. Air was injected at intervals of eight minutes, in quantities of 30 c.c. each, until the enormous amount of 480 c.c. had been introduced. After the first injection nothing was observed that indicated the presence of air in the veins or the heart. After the second dose, a stight splashing sound could be heard over the cardiac region, which became louder and more distinct as the amount of air in the right side of the heart increased. The first serious symptoms observed were a tumultuous action of the heart and difficulty in breathing, which became aggravated by every subsequent injection. Towards the end of the experiment, which lasted nearly two hours, the animal was attacked, at short intervals, by general convulsive movements. After the suspension of respiration, the heart's action became very slow and feeble, and at times irregular. The immediate cause of death was plainly due to asphyxia, as manifested by the great dyspnea and the cyanotic hue of the visible mucous surfaces. On examination after death, a few air-bubbles and only a small amount of dark blood were found in the left ventricle. The right ventricle was arrested in diastole, and contained a large quantity of very dark, almost black, spumous blood. Air-bubbles were found in a number of distant arteries of small size.

Experiment 5. — Adult, large cat. In this instance the cannula was introduced and tied in the left jugular vein. The heart was exposed before the injection was made, with a view of observing directly the effects produced by sudden inflation of the right cavities of the heart. Before the air was introduced, the heart contracted regularly; artificial respirations being made for the purpose of preventing death by asphyxia. As soon as the right side of the heart was dilated by the air, the left auricle and both ventricles ceased to contract, while the right auricle continued to pulsate. The pulsations were feeble and irregular. The coronary veins became filled with air-bubbles, presenting the appearance of a rosary. On opening the superior vena cava, air and frothy blood escaped, the right side of the heart collapsed, and all chambers of the heart commenced to contract regularly and with considerable force. The pulsations continued for from fifteen to twenty minutes, becoming more feeble and irregular and intermittent towards the last. After death, air was found in both venæ cavæ and the iliac veins. The left ventricle was completely empty. In this case, owing to the small size of the heart and the large amount of air introduced, the contractions of the right ventricle were arrested in the diastole, but respiration continued. Death took place suddenly from overdistension of the heart.

Experiment 6. — Medium-sized cat. Injected 15 c.c. of air into left jugular vein. Heart's action arrested at once. The respirations, which were irregular, ceased a few moments later. The chest was opened at once. The right side of the heart was found enormously dilated and almost motionless. Coronary veins filled with air. The right ventricle was punctured with the needle of an aspirator and its contents withdrawn, when the pulsations were re-established. The ventricle was again inflated through the needle of the aspirator. Five

minutes after this injection the pulsations numbered about 250 per minute. Five minutes later the left auricle ceased to contract, the movements of the right being irregular and about 80 to the minute. After the lapse of another five minutes the pulsations of the ventricle were only 17 a minute, and a little later all movements ceased. This experiment demonstrates that the arrest of the heart's action was due to mechanical overdistension, as aspiration of the right ventricle was followed by regular and strong contractions of the cavities of the heart. The contractions were not the result of the mere mechanical irritation of the heart by puncture, as other and equally severe irritants had been previously applied without producing any effect.

Senn's conclusions are that his experiments tend to prove the following statements:

1. A small amount of air in the right side of the heart in a healthy animal gives rise only to temporary symptoms, referable to the heart's action and the pulmonary circulation.

2. When air has been injected into the right side of the heart in such quantities as not to arrest the contractions of the heart itself, it is forced through the pulmonary capillaries into the left side of the heart by the contractions of the right ventricle.

3. The danger attending the insufflation of air into veins is proportionate to the amount of air introduced, as well as to the capacity of the right ventricle to resist intracardiac pressure.

4. When a fatal dose of air has been introduced into the circulation, death takes place almost instantaneously from arrest of the heart's action, or later from suffocation.

5. Spontaneous ingress of air into a wounded healthy jugular vein never occurred in these experiments, and must be considered almost a physical impossibility, as the resilient walls of the wounded vein collapse readily when exposed to atmospheric pressure.

Hare (*Therapeutic Gazette*, 1889, p. 606; *American Journal of the Medical Sciences*, Oct., 1902) deliberately injected air into the jugular veins of dogs for the purpose of seeing how large quantities could be borne without producing death, and demonstrated his conclusions from these injections to the medical students of Pennsylvania University, where he was then teaching; to several of his colleagues; and finally to the Philadelphia Medical Society. On this occasion Hare injected 60 c.c. of air into the jugular vein of a small dog weighing 12 pounds without the production of any symptoms whatever. Hare reports experiments on some seventy dogs, and asserts that even large quantities of air do little if any harm. Hare also states that he has injected a considerable amount of air, amounting to as much as two to three cubic centimeters, into the median basilic veins of two human beings without producing any symptoms whatever, while a third patient, who received a similar dose, afterwards had a decided rigor, but no other untoward symptoms.

EDITORIALS

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THE DANGERS OF SCOPOLAMINE-MORPHINE ANÆSTHESIA

A word of warning at the present time as to the possible dangers of scopolamine-morphine anesthesia cannot be amiss. It is well for the conservative surgeon to consider carefully the reports of deaths which are said by the authors to have been due to the administration of this anesthetic, before he resorts to its use. We do not for a moment wish to discourage experimental investigation. However, it is a question whether one is justified at the present time in making use of the anesthesia when so many surgeons of well-known ability and judgment have ceased to use it, or use it only with great care and judgment. In relation to the fatal cases it should be remembered that when they have been reported by reliable observers as being possibly due to the scopolamine-morphine, the burden of proof rests with the advocates of the procedure, rather than with its opponents; and when numerous observations have accumulated of fatal cases in which the death ensued in a similar manner after its use, it is only fair to our patients that we should wait for the advocates of the method to prove that death was not due to scopolamine-morphine, rather than proceed with this method of anesthesia and run the risk of fatal termination.

In this relation, De Maurans, the editor of *La Semaine Médicale*, who has been radically opposed to this procedure, published early in the year an article in which he collected twelve fatal cases, due possibly to the method of Schneiderlin. Lately he has, in the same journal, reported further fatal cases, and has taken the trouble to inquire of various surgeons as to their opinions upon this subject. Flatau wrote that he had not made use of this method of anesthesia since the fatal case which he had already reported. Dirk remarked that it should be administered with prudence, and especially in aged and feeble patients great care was to be taken, and the second dose to be omitted where, in about an hour, profound somnolence came on with pupillary dilatation and cyanosis. Israel responds to De Maurans' letter, saying he did no know whether or not his deaths had been due to the narcosis, and that he allowed each one to form his own opinion after studying the cases. He mentioned that in two of them, which succumbed in about two hours with extensive degeneration of the parenchymatous organs, Professor Orth expressed the opinion that if the condition found was not due to a phosphorus poisoning, one could not distinguish it from that produced by such a poison. The cases had been given 18 to 25 c.c. of chloroform, in addition to the scopolamine. Israel brings up the question whether or not scopolamine-morphine with small doses of chloroform or ether may not produce extensive lesions, which either of the latter alone is incapable of in the same sized doses.

Ziffer reports three observations in which there was a reasonable doubt as to whether or not the death might have been due to the anesthetic; however, taken in combination with other reported cases similar in their manner of death, they are extremely suggestive. Zahradnicky reported 1 death in 232 cases, and in answer to the letter sent him, wrote that he had ceased to use that method of anesthesia after that death, especially since he had been able to collect reports of 6 deaths in 650 cases, constituting an enormous mortality. Lovrich, assistant in the First Gynecological and Obstetrical Clinic of Budapest, under Professor Barsony, reported 50 cases, with 2 deaths; and in this relation Barsony wrote to De Maurans that scopolamine is a cardiac poison which cannot be regulated, and that its influence upon the heart is not due alone to the size of the doses, but also varies in the individual to whom it is administered, and as a consequence of these 2 cases he has definitely excluded narcosis by scopolamine from his clinic. In the Second Clinic at Budapest, in consequence of one death in a hundred, they have ceased to use Schneiderlin's method.

Altogether, De Maurans collects, in this new series, 10 fatal cases which he believes to have been due to the scopolamine-morphine — 6 women and 4 men. It is interesting to note that of 8 of these cases, in 4 the anesthesia was reinforced by ether and in 4 by chloroform. This, statistically at least, seems to prove that the original assumption that chloroform was less dangerous than ether in these cases is without justification. After considering the reports, De Maurans states, " It is not the age of the patient, nor the doses of anesthetic employed, nor the manner of operation, nor the choice of anesthesia to reinforce it, that is responsible for these deaths, but they ought to be attributed to the scopolamine itself."

De Stella, by experimental researches, has shown that scopolamine acts principally upon the center of respiration, and secondly upon the heart. A review of these reported cases shows that practically all of them died as a result of an arrest of respiration accompanied by cyanosis. Moreover, it did not occur by simple depression of the respiratory function, but was often accompanied by Cheyne-Stokes respiration, suggesting a paralysis of the centers in the medulla. In view of these facts, it would seem advisable for the conservative surgeon to await further animal experiments before resorting to this procedure, rather than jeopardize the lives of patients intrusted to his care.

CYSTOSCOPY

Cystoscopy, the direct examination of the interior of the urinary bladder by ocular inspection, has been only in recent years accepted more generally by the surgical profession. The reasons for this delay in taking up such a useful and valuable method of exploration were manifold.

Firstly, of course, came the technical difficulties and shortcomings. As a matter of fact, cystoscopy was first placed on a practical and generally acceptable basis after Nitze introduced his two principles: introduction of the source of light into the viscus proper, and the enlargement of the field of view by including an appropriate telescope within the instrument.

But even after the technical features were highly developed the profession hesitated to take up cystoscopy, mainly for the reason that, as a rule, cystoscopic examinations were not made systematically, but only occasionally,— when a case, so to say, forced the cystosc pe into the hands of the surgeon. It was not surprising, then, that in a difficult case one not equipped with previous experience would fail to elicit satisfactory results. It has been a frequent mistake to expect that the cystoscope would work like a charm, and would furnish results without calling for the application of

experience, logic, and comparisons with normal conditions, which form such an intrinsic part of the diagnostic art. Often it was supposed that all that was necessary in order to make a diagnosis was to insert the cystoscope into the bladder. If the observer, under such circumstances, failed, the whole method was denounced as ineffective, and was condemned and dropped.

Another obstacle was placed in the way of the general acceptance of cystoscopy, in that men recognized as leading surgeons, like Pawlik and Kelly, still advocated cystoscopic methods that necessitate air-dilation of the bladder. The disagreeable features of this proceeding—the dilation of the urethra, the necessity of employing general or local anesthetics, as well as placing patients in repulsive and disagreeable positions—certainly prejudiced a great many surgeons against cystoscopy in general.

Another instance was that prominent surgeons, relying on their vast experience, their intuition, and their virtuosoship, declared cystoscopy unnecessary for exact diagnosis, thus deterring their following from taking up this method of examination. Thus it happened that for many years cystoscopy remained a kind of a mysterious monopoly, practised and exploited by only a few; but, after the younger generation of surgeons was trained more and more in the recognition of exact methods of exploration and diagnosis, cystoscopy gained ground, and is now one of the firmly established aids of surgery. This recognition, expressed itself in the fact that a great many modifications of the original instruments were introduced, each cystoscopist trying to modify the instruments according to his own personal wants and ideas. The greatest advancement in the popularity of cystoscopy was accomplished when it was shown of what importance cystoscopy could be for the diagnosis, prognosis, and treatment of pathologic conditions of the kidneys. At the present time, the standing of cystoscopy can be summed up as follows:

The modern cystoscopes, built after Nitze's ideas, are of such a size and shape, that, except in very rare instances, they can be used to full satisfaction without the employment of even local anesthesia, and without causing more discomfort to the patient than an ordinary sounding would. There is no necessity for placing the patient in disagreeable positions. On account of this it has been possible to examine systematically a great number of individuals; in this way a vast store of knowledge has accumulated, thus defining all the different pictures a healthy bladder can offer, and differentiating them from pathological conditions.

It became possible to compare the clinical symptoms with the findings of cystoscopic exploration, and to correct or confirm cystoscopic diagnosis and determination by the findings at operation or post-mortem.

The whole chapter of vesical catarrh and cystitis—for years a confusing chaos—became classified by systematic research, so that at the present time desquamative catarrh, gonorrheal cystitis, tuberculous cystitis, and various other types, are well defined in their pathological, clinical, and cystoscopic characteristics.

The knowledge that obstinate cystitis might be maintained by torpid ulcerations is one of the achievements of cystoscopy, and it is hardly conceivable how a solitary ulcer in the bladder could be diagnosed without direct inspection.

There is no way so clear, decisive, and certain in diagnosing tumors of the bladder as by the use of the cystoscope. We get information as to the relations, as to the shape, as to the size, and as to the surface of the tumor. Incidentally, it is interesting to mention that cystoscopy did away with the erroneous belief that the majority of vesical hemorrhages was due to bladder tumors. Now we know that most of

these hemorrhages originate in the prostate, in varicose veins, and in ulcerations.

A vesical calculus might escape detection, even if the most experienced hand uses the explorative sound, but the cystoscope will hardly fail to detect the stone, and at the same time it will give full information as to the nature of the stone, as to its size, and as to its location; it will tell whether the stone is free or partially encysted. The same exploration will furnish all the details about the condition of the bladder-wall. How important all these points are in deciding upon the choice of operation does not need any explanation.

Cystoscopic examination, especially executed with the retrospective cystoscope, gives very valuable, and very often indispensable, information in prostatic disturbances. The observer determines the presence or absence of inflammation; he is in a position to decide which lobes are enlarged; he can find out whether the bulk of the prostatic hypertrophic growth tends towards perineum or into the viscus. It is certainly impossible to make the diagnosis of a Holmes lobe without the aid of the cystoscope. The above-mentioned points will enable the surgeon to decide intelligently upon the operation to employ in order to relieve prostatic obstruction.

Pyuria and hematuria remain puzzles in spite of all microscopical examinations and in spite of the most logical deductions until the cystoscope reveals the fact whether the pus or the blood is coming from the prostate or from the bladder proper, or whether these pathological secretions come down from the kidneys.

Since we learned to diagnose the edema bullosum, we are able to recognize the presence of a pericystitis, or the attachment to the bladder of other inflammatory tumors, as parametritic exudates or pyosalpinx.

Diverticula, so often a cause of great distress for the patient, were repeatedly successfully removed after having been diagnosed through the cystoscope, and the inflammations around a patent urachus lost their mysterious characters since the cystoscope repeatedly diagnosed such cases readily and correctly.

Endovesical operations performed through an operative cystoscope in a great many cases brought relief in healing up specific and non-specific ulcerations, in removing benign tumors, and in stopping hemorrhage and pain caused by inoperable malignant tumors, — all this without subjecting the patients to the dangers and to the tedious after-treatment of suprapubic operations.

In detecting and removing extraneous bodies, cystoscopy certainly had and has triumphant success.

Vesicovaginal fistulæ evry often furnish an object for important cystoscopic examinations. If the fistula is located near the trigonum, it is of paramount importance to investigate the relation of the ureteral openings to the edge of the fistula, so as to avoid any injuries to the ureter in freshening the cicatricial edges; the indication for a flap operation becomes imperative if the cicatricial tissue includes the vesical part of the ureter. Satisfactory distension of the bladder with water, in order to carry out successful cystoscopy, can always be accomplished, either after the fistula is temporarily closed by short clamps or after the vagina is tightly packed with wet absorbent cotton.

Modern kidney and ureteral surgery found a most powerful ally in cystoscopy. The simple ocular inspection of the ureteral openings will lead our diagnostic *raisonnement* in certain directions; a protruding, gaping, or injected ureteral mouth indicates almost invariably some pathological condition in the kidney, and makes further searching investigation in this direction imperative; repeatedly impacted ureteral stones were seen half-way

protruding out of a ureteral opening, and the operative cystoscope relieved this condition.

If we find ulcerations around the ureteral opening, and the ureteral mouth proper inflamed, we at once make the diagnosis of a vesical infection coming from above, and the search for tubercle bacilli becomes necessary.

Since the perfecting of the modern instruments made the catheterization and sounding of the ureters a rather simple procedure, great advances have been made in diagnosis and therapy of pathological conditions of the ureters and of the kidneys. A sound introduced into a ureter will give information as to the patulence of this tube; it will permit one to locate the seat of an obstruction. The scratches on the wax-tipped ureteral catheter of Kelly will demonstrate the presence of a ureteral calculus. Cystoscopy, catheterizing, and sounding of the ureters will give valuable information as to the side and the height of the lesion in case of post-operative ureteral fistula, and in some instances ureteral fistulas were cured simply by the application of a permanent ureteral catheter.

Since I demonstrated some ten years ago that an impacted ureteral stone can be liberated from its incarceration and brought down into the bladder by running up a ureteral catheter to the seat of impaction and by the subsequent injection of vaseline oil, this method has been employed repeatedly and successfully by other surgeons. A wide field of usefulness was opened for ureteral catheterization through the increasing demands put upon our diagnostic methods by the rapid development of kidney surgery. It became important to collect separately the urine of either kidney. Cystoscopy and ureteral catheterization helped to develop a new clinical entity and a new surgical problem: the functional capacity of the kidneys. Chromocystoscopy, cryoscopy, electric conductivity test become possible and efficacious only by the employment of cystoscopy and ureteral catheterization. The combination of X-ray examination and ureteral sounding was another step in refining our diagnosis. If a ureteral catheter armed with a metallic stilette or mandrin is inserted into the ureter, the course of the ureter is unmistakably outlined on the skiagram. The advantages of the appearance of this shadow on the X-ray picture are obvious. The relation of the ureteral shadow to that of a tumor of doubtful nature will tell whether this tumor is of renal origin, and if the shadows of supposed ureteral calculi are not in intimate connection with the ureteral shadow, the erroneous diagnosis will be corrected. The relation of the tip of the armed catheter to the shadow of a renal stone will determine whether the renal calculus is located in the renal pelvis or in the parenchyma of the kidney.

In plastic operations on the upper end of the ureter or on the renal pelvis, a ureteral catheter, inserted previous to the operation, will, as a rule, be a very helpful guide. In fact, there is hardly an instance in bladder and renal surgery in which cystoscopy, if not entirely indispensable, at least will be a very desirable factor in diagnosis, prognosis, and treatment.

G. KOLISCHER, M. D.

TRANSACTIONS OF SOCIETIES

CHICAGO MEDICAL SOCIETY

Abstract of Paper and Discussion upon Suprapubic versus Perineal Prostatectomy

At the meeting Nov. 14, 1905, William T. Belfield, M. D., read a paper upon Operative Treatment of Prostratic Hypertrophy.

Evolution.—The deliberate removal of prostatic obstructions to urination, begun by myself in 1885, has passed through various stages of evolution. The survival of the fittest leaves four operations worthy of consideration to-day: 1. Channeling the obstruction by galvanocautery, guided by the finger, both introduced through a median perineal urethrotomy — "galvanoprostatotomy"; 2. Partial removal of the prostate through a median perineal incision—"Partial perineal prostatectomy"; 3. Removal of the entire prostate through a transverse, curved, or V-shaped perineal incision—"perineal prostatectomy"; 4. Removal of the entire prostate through a suprapubic incision — "suprapubic prostatectomy." Each of these species includes several minor varieties.

Galvanoprostatotomy and partial prostatectomy has each its legitimate though narrow field, in which it is both anatomically and surgically superior to total prostatectomy.

Varieties of Prostatic Obstruction.— The commonly met obstructions to urination by the senile prostate are of four kinds: Pus infections, sclerosis, adenoma, carcinoma. The clinical recognition of these different conditions is essential; the general practice of regarding all urinary derangements in elderly men as due to "prostatic enlargement," and as curable by prostatectomy, is the explanation of many failures in prostatic surgery.

1. *Pus infections*, without true hypertrophy of the prostate (though this organ naturally exhibits inflammatory enlargement), are common in men over forty-five. They are curable, in the early stages, by massage of the prostate from the rectum, injections of the posterior urethra with silver nitrate solution, with or without the retained catheter. The later stages are often refractory to this treatment, requiring surgical relief.

2. *Sclerosis* of the prostate and vesical neck is requent without notable enlargement of the prostate; this is the so-called "prostatism without a prostate," this organ is very hard, and *cannot be enucleated by any method.* While it can be removed by morcellement through a perineal incision, this method is inferior to galvanoprostatotomy, because more severe, and prone to induce cicatricial contraction of the bladder neck, with a fistula.

3. *Adenoma* — the real prostatic hypertrophy — can usually be enucleated, and furnishes the gratifying cases of prostatectomy.

4. *Carcinoma* is found in about one case out of every ten of so-called hypertrophy, from which it is not always distinguished; indeed, it is certainly in special cases a transformation of simple hypertrophy (adenoma). Until it invades the prostatic capsule, carcinoma is removable; but the operation is bloody and severe, and the ultimate results a doubtful compensation.

Any two or all of the three first-named conditions may coexist in the same prostate; hence no single method can suffice or succeed in all cases of so-called "prostatic enlargement."

Urinary Retention without Prostatic Enlargement.— Exactly the symptoms induced by prostatic enlargement — urinary retention and cystitis — occur in elderly men whose prostates are not diseased. The commonest causes are tabes dorsalis, sclerosis of the vesical walls secondary to cystitis, vesical diverticula, calculi, and carcinoma. Naturally, these are not cured by prostatectomy.

Limitations of Operations.— Galvanoprostatotomy is the practicable operation for sclerosis of the prostate and vesical neck; even when the other conditions coexist, this operation may be wisest for feeble patients, because of its relative safety.

Partial perineal prostatectomy — the chief advantage of which over total prostatectomy has been its lower mortality — is losing favor as the fatality of the complete operations is steadily and rapidly decreasing, since its percentage of cures is naturally smaller than theirs.

Total prostatectomy, which removes all urinary obstructions caused by the prostatic enlargement, should, it would seem, entirely relieve those who survive it of their urinary troubles; yet

not more than fifty or sixty per cent empty their bladders completely and are otherwise normal. The reason for the large percentage of failures is chiefly the neglect of surgeons to differentiate the various morbid conditions of prostate and bladder common to elderly men; there are too many who regard all urinary derangements in possessors of gray hairs as due to prostatic hypertrophy, and curable by immediate prostatectomy. Sclerosis of the vesical walls secondary to infection (cystitis), atony of the bladder, tabes dorsalis, carcinoma, sclerosis, and suppuration of the prostate, even vesical calculi, are overlooked in the present frenzy to make a prostatectomy, which of course fails to relieve the subjects of these morbid conditions.

Comparison of Suprapubic and Perineal Prostatectomy.— The perineal is still the operation of choice in France and the United States, though its most ardent advocates now admit that middle lobes, at least, are more accessible from above. Thus Murphy makes the transvesical operation in about twenty-five per cent of his cases. It is generally admitted that perineal prostatectomy has produced a large army of sufferers from urinary incontinence, perineal and rectal fistulæ, cicatricial contraction of the bladder neck, besides various minor ailments. It is generally admitted that the suprapubic operation entails none of these distressing sequelæ, and that the functional results secured by it are more uniformly good than are those of the perineal, which gives only about forty per cent of cures. These distressing sequelæ of the perineal operation are apparently due, not to the destruction of the prostatic urethra, since the epithelium of the urinary tract is vigorously and extensively regenerated, but to the extensive cicatrix formation following the operation.

Why, then, is the perineal operation preferred? Because of its smaller mortality. The fatality directly attributable to the perineal operation in several hundred cases collected by Escat, Proust, and Watson ranges from six to eleven per cent, that of suprapubic prostatectomy has been from eight to fifteen per cent, though Freyer's mortality from this operation has been reduced from ten per cent in his first hundred cases to three per cent in the last thirty-six cases reported.

The smaller mortality entailed by the perineal operation, and this alone, is frankly admitted by its experienced advocates to be its sole advantage over the suprapubic method, and the sole reason why they prefer it in spite of its many unfortunate sequelæ. Thus Escat admits that in 410 cases reviewed by him a urethro-perineal or rectal fistula persisted in over eight per cent, and permanent incontinence in over three per cent, and that the suprapubic operation is practically free from such untoward results, which often cause the patient far more distress than he endured before the operation.

Proust, the pioneer in modern perineal prostatectomy, and Albarran, the foremost operating genito-urinary surgeon of France, while still practising the perineal operation, admit that in every phase, except mortality, the suprapubic gives better results; and they express the opinion that improvements in technique, by materially reducing its mortality figures, will make suprapubic prostatectomy the preferred and standard operation.

Improvements in Technique of Suprapubic Operation.— Now, the higher mortality of the transvesical operation has been chiefly due to septic infection of the suprapubic tissues, and the elimination of this feature would render it the preferred method. To this end, various devices have been employed, including siphon drainage, suture of the vesical wound around the drain-tube, or to the muscular aponeurosis, or even to the skin; but for obvious reasons none of these can be relied upon to prevent all leakage of urine into the prevesical tissues. A drain from this space under the pubic arch through the perineum prevents accumulation of septic fluids in Retzius's space, but does not prevent infection; and the severity and danger of such infection are determined by the quality rather than the quantity thereof. Continuous immersion of the patient's pelvis in a warm bath is an effectual but seldom practicable protection against sepsis.

One radical defect vitiates all efforts at suprapubic asepsis: *the drainage is against gravity;* urine and tissue fluids stagnate in the bladder, and rise into the wound. Successful drainage must be toward a lower level; in other words, *the proper drainage of the suprapubic wound is into the bladder and through the perineum.*

Perineal urethrotomy, with the introduction of a large metallic drain, adds almost nothing to the gravity or time of the operation, but affords perfect drainage, not only for the urine, but also for the oozing from the suprapubic wound. To insure the latter, the anterior angle of the bladder incision should be close to the pubes, and should be left unsutured for the passage of a small rubber drain from the skin to the bladder. This drain affords passage, not for the urine out of the bladder, but for the tissue fluids into the bladder, whence they escape by the perineal tube. This drainage of the suprapubic wound into the bladder by gravity is rendered doubly sure by frequent or even continuous irrigation through this suprapubic tube.

It is essential that the perineal drainage-tube be

of metal; for a rubber tube sometimes fails to drain, because compressed by the inflammatory swelling of the vesical orifice, or through kinking within the bladder. Hence has arisen the amiable delusion, shared even by experienced surgeons, that the urine will escape by the suprapubic rather than by the perineal wound. With the metallic perineal tube the suprapubic space remains free from urine, unless the drain become plugged by a clot — a possibility minimized by the size of the tube and the irrigation from above.

The perineal incision, moreover, facilitates the enucleation of tumors lying deep in the prostate; it serves to detect and dilate the sclerosis of the vesical orifice, which is often an important, sometimes the sole, cause of urinary retention, even when adenomata coexist. This accessory to the suprapubic incision is regularly employed by Israel, among others.

The enucleation wound is packed with gauze strips whose ends are brought through the perineal wound and removed on the third or fourth day, when the metal drain is replaced by a retained catheter, and the patient allowed to sit up in bed.

Two-stage Operation. — Another effectual measure against suprapubic sepsis, especially desirable for feeble patients, is the division of the operation into two stages — the first including the incision to the bladder and packing of the wound with gauze; the second, performed three or four days later, comprising the incision through the bladder-wall and the intravesical operation. The serious objection to this has been the dangerous repetition of general anesthesia within a few days (local anesthesia does not suffice for the first stage, as might be imagined without a trial). This danger is eliminated by the use of nitrous oxide for anesthesia. That this gas can be safely used for prolonged narcosis, without oxygen admixture, I learned from a paper read to this society some eighteen months ago by Dr. Bertha Van Hoosen. This relieves the two-tempo operation from chloroform or ether dangers, and, through the immunity to infection afforded by a granulating surface, minimizes the greatest danger of suprapubic prostatectomy, that of prevesical sepsis.

Fourteen patients over sixty years of age, operated in two tempos, have recovered without serious symptoms.

Summary.-1. Urinary retention in elderly men is caused by various conditions, other than prostatic disease. These should be searched for before operation upon the prostate is undertaken.

2. Of the four frequent prostatic diseases causing urinary retention and cystitis in elderly men, one — sclerosis — often exists without noteworthy enlargement of the rectal surface of the organ, which is, however, notably hard. The remaining three — pus infection, hypertrophy (adenoma), and carcinoma — commonly produce distinct enlargement of one or both lateral lobes.

3. The sclerotic prostate cannot be enucleated through any incision; it can be removed by morcellement, or channeled by galvanocautery through a median perineal incision — the latter seemingly safe and free from the danger of fistula formation.

4. The adenomatous prostate can be enucleated through either the suprapubic or perineal incision. The chief merit of the latter is its relative freedom from sepsis, and consequent lower mortality. Its chief demerits are: (*a*) Difficulty of enucleation from depth of perineum; (*b*) Permanent fistulæ into perineum and rectum; (*c*) Permanent incontinence of urine; (*d*) Cicatricial contraction of perineal urethra.

The merit of the suprapubic operation is the better command of prostate and bladder; its one serious demerit has been the high mortality. This has arisen from septic infection of the prevesical tissues, and this, in turn, from drainage against gravity. Hence the immediate results of the perineal have been distinctly better, its ultimate effects notably worse, than those of the suprapubic operation. It cannot be accepted as a satisfactory solution of the problem.

5. Proper perineal drainage seems adapted to remove the immediate evil of the suprapubic without adding the ultimate evils of perineal prostatectomy, especially if the former be made in two stages.

DISCUSSION

Dr. Alexander Hugh Ferguson spoke in favor of the perineal route. He had had some experience with the suprapubic route before he began to do prostatectomy through the perineum. The diagnosis of obstruction could not, sometimes, be made until the finger was introduced into the bladder through the perineum, which could not be done very well suprapubically. There were certain prostatic conditions which were not operable from above. Freyer attempted this in one case in which it was absolutely impossible for him to remove the prostate suprapubically; he quit operating, and his patient died. Post-mortem examination showed that the cavity he was digging into was full of putrid blood-clots, also the bladder.

With regard to the total removal of the gland, this could be accomplished through a perineal incision, but not through a suprapubic very well. Surgeons removed more than the gland; they removed the prostatic urethra as well by the supra-

pubic route, and had claimed that no harm came from it; whereas by the perineal operation the prostatic urethra could be saved sometimes. The surgeon could save the interior portion of it and enucleate the gland from around it, so that the perineal route for total prostatectomy was more conservative, inasmuch as only the diseased portion was removed and the prostatic urethra left alone when it was normal.

As regards fistula, rectal fistula occurred sometimes on account of roughness in manipulation by the operator, or of the operator using, possibly, sharp instruments and injuring the rectum. He had had no urinary fistula following operations on his cases. He recalled one case of stricture occuring after the suprapubic operation, the patient having been operated upon by another surgeon three years previously for the removal of the prostate. The stricture was situated at the neck of the bladder, and barely admitted a filiform bougie. He managed to dilate the stricture, allowed urine to escape, but the patient died inside of forty-eight hours thereafter. Post-mortem examination revealed the annular form of hard stricture at the neck of the bladder which had followed the suprapubic operation. Strictures from the perineal operation were exceedingly rare. He mentioned one such case that occurred in his practice. The mortality from the suprapubic was greater than from the perineal operation.

Dr. Weller Van Hook stated that what was needed for the treatment of old men with prostatic difficulties was an operation so simple, so quickly performed by the skilled surgeon, that old and feeble men would be given immediate relief. The perineal operation by enucleation of the prostate did this. The operation he had performed for four or five years could be done in from four to fifteen minutes under nitrous oxide gas anesthesia, which could be maintained very easily in operations of all sorts for a few minutes, or half an hour or longer, if desired. He felt sure that the suggestion of Dr. Belfield to do suprapubic prostatectomy in two sittings would be of great value to the advocates of that method, in that it would help to eliminate infection of the suprapubic space or cavity of Retzius. It was not apparent to the speaker that a combination of the suprapubic and perineal routes would be followed by less sequelæ than when the perineal route alone was employed. He agreed with Dr. Ferguson that by attacking the prostate through the perineum we were enabled to undertake operations upon men so old and feeble that a suprapubic operation would be out of the question. He did not select cases for prostatectomy, but operated upon them as they came, feeling that the removal of the prostate itself added very little to the necessary perineal section.

Dr. E. Wyllys Andrews said that prostatectomy was undergoing evolution. He agreed with Parker Syms that at the present stage of operative work some cases of enlarged prostate could be better treated by the suprapubic than by the perineal route, making all allowance for the imperfections of methods. He was inclined to agree with the essayist that, on the average, one could do a quicker and better prostatectomy through the suprapubic route than he could through the perineal. This was not true of all cases, as much depended upon the type of prostate to be removed. The speaker had drifted into the type of operation known as the Goodfellow, and thought it was an excellent method.

Dr. F. Kreissl said there were certain elements of danger connected with prostatectomy, some of which had been overrated, while others could not be emphasized too much. But the real elements of danger were present in the perineal operation, just as they were in the suprapubic route. Take an infected urethral tract of a very old, enfeebled, and emaciated man, the danger was not so much from hemorrhage as from infection. If these conditions could be overcome by the method advocated by the essayist, it offered very good prospects for a certain type of patients who were in a badly infected condition, and who were perhaps not fit subjects for either suprapubic or perineal prostatectomy, but might be subjected to the Bottini operation, which was performed now under a general anesthetic, but which, in many cases, was only a temporary measure of relief, because recurrences had been noted. This operation might be reserved for old men.

Dr. A. E. Halstead was a strong advocate of the suprapubic method. From a rather limited experience with this method he had come to the conclusion that about eighty per cent of the prostates met ,with in actual practice, and which demanded removal, could be taken out best through a suprapubic opening. He had followed, in his operations, the technic advocated by Dr. Belfield a number of years ago, and had had no serious difficulties, so far as removing the gland was concerned. The danger of hemorrhage from the suprapubic operation was not great, because if one was within the capsule of the prostate the prostatic veins were in no danger of being injured, and enucleation of the prostate could be effected with prac-

tically no loss of blood. Drainage and the great risk of infecting the prevesiscal space was overrated. Of course, there was a certain risk, but with a proper technic, so far as draining the suprapubic area was concerned, the risk was minimal. In his operations he had secured perfect drainage of the bladder by siphonage, without, in any case, having infection of the prevesical space.

As to the length of time consumed in removing the prostate, the suprapubic operation surely did not take any longer than the perineal. The actual time consumed was anywhere from two to ten minutes in removing the prostate after the bladder was opened. In the great majority of cases the prostate could be removed through a suprapubic opening within five minutes. In doing suprapubic cystotomy the time required for getting into the bladder was from ten to fifteen minutes, so that the entire operation could be completed in twenty minutes, and this was as short a time as any in which a perineal operation could be performed.

Dr. Edward F. Wells said he would like to hear an expression of opinion as to the character of patients that should now be submitted to operation. He took it, that patients with vesical infection and enlarged prostates, in which the infection might be high up, demanded operation. Were there cases in which the operation might be advised,— namely, in cases of early catheter life, in the first or second year, with very little infection of the bladder, with competent kidneys, and no infection of the tracts above, but where the patient was required to use the catheter five or six times a day to enable him to void urine? Without the use of the catheter, were we in a position to advise a patient to undergo an operation of this character either performed suprapubically or perineally?

Dr. Gustav Kolischer stated that the dangers attending perineal prostatectomy, or sequelæ, were perineal fistula, rectal fistula, urethral stricture, incontinence of urine, and total impotency, or loss of sexual power. Published statistics would vary as to results and mortality if the miraculous statistics of those who had never had a failure were cut out, and who had never lost a patient. Any man who had performed a great number of perineal prostatectomies and had not had cases of perineal fistulæ, strictures, incontinence of urine, must have been singularly fortunate. Surgeons had removed prostates through the perineum and had failed to detect concrements in the bladder. He cited a case where, a few days ago, Dr. Belfield examined a patient whose prostate had been removed through the perineum by a good surgeon, and had found a concrement in the bladder which could not have formed in the time between the operation and the examination which was made by Dr. Belfield.

He did not think any surgeon would care to make the statement that he could remove a prostate or prostates by the perineal route without injuring the prostatic urethra, more or less. The prostatic urethra was so intimately connected with the capsule of the prostate, that it mattered not whether one did the suprapubic or perineal operation; he was almost certain to injure the prostatic ducts or the prostatic urethra. How could a man speak of removing a prostate, especially if there was periprostatitis, infection, without injuring the prostatic urethra? Annular stricture was the consequence, largely, of an old periprostatitis, and the suprapubic operation would cause annular stricture at the neck of the bladder.

Dr. William Fuller stated that nothing could be more desirable than perineal prostatectomy, as practised and recommended by Dr. Ferguson. It was the quickest, safest, and the best way of removing the enlarged prostate gland. However, there was one point referred to by Dr. Ferguson in reference to this operation that he could not understand. This was, that in perineal prostatectomy he could remove the prostate gland without injuring the prostatic urethra. The speaker had removed the prostate gland repeatedly from the cadaver with the bladder and the lower end of the ureters, and had tried to dissect the prostate gland away from the prostatic urethra, but had never been able to do it without injuring it.

Dr. Belfield (closing the discussion): As Dr. Andrews has aptly said, the operative removal of the hypertrophied prostate is undergoing evolution, and the process is not yet complete. It began here in Chicago nineteen years ago with suprapubic prostatectomy; its progress was interrupted by the castration diversion and the Bottini ghost-walk, but was resumed in the form of perineal prostatectomy six or seven years ago — thanks especially to Proust and Albarren in France and Ferguson and Murphy in America.

One of the best results of the perineal operation is that it has disclosed to general surgeons the fact that prostatic hypertrophy is but one of several diseases to which the senile prostate is prone; and that prostatectomy should not be made without a preliminary differentiation between the cases that probably will, and those that certainly will not, benefit by the operation. No more potent argument for this could be furnished than the facts that less than half the prostatectomies heretofore per-

formed seem to have cured the patients of their urinary difficulties; that even skilled surgeons have endeavored to enucleate small fibrous prostates; and that less skilled surgeons have performed prostatectomy on subjects whose bladder symptoms were caused by locomotor ataxia or even vesical calculi.

Perineal prostatectomy has been a valuable lesson in prostatic surgery; but even its creator, the French school, is looking for something better, something that will not leave eight per cent with permanent fistulæ, three per cent with permanent incontinence, and many others with a mass of cicatricial tissue compressing the deep urethra — in short, toward suprapubic prostatectomy as practised by Freyer.

Dr. Ferguson has been fortunate in escaping these distressing results of the perineal operation. As I have recently observed six cases of fistula and one of permanent incontinence following this operation performed by others, it would seem that these sequelæ are not rare.

Freyer's failure to remove a fibrous prostate through the suprapubic incision is not, as Dr. Ferguson intimates, an argument against this operation; nor would I argue that Albarran's three failures to remove such prostates through the perineal incision should condemn that operation. All such experiences merely emphasize the necessity for recognizing the varieties of prostatic obstruction.

The argument that the prostate, because extravesical, should not be approached through the bladder, seems scarcely convincing to those who usually approach the extraperitoneal appendix through the peritoneal sac.

That an expert surgeon may make a perineal prostatectomy without discovering a stone of good size in a bladder diverticulum, has been brought to my attention in three cases. This could hardly have happened had the operator's finger sought the entire bladder through a suprapubic incision.

Dr. Wells's question — the indications for prostatectomy — must be answered in each individual case. In general, acute vesical infection must be reduced by urotropin, the retained catheter, etc., before operation.

The perineal operation has been thoroughly tried and found seriously wanting; we are looking for something better.

SYMPOSIUM ON THE TREATMENT OF FRACTURES

Dr. R. S. Dubs read a paper at the meeting Nov. 23, 1905, entitled Fracture of the Femur Treated by the Ambulatory Method, and exhibited a patient.

The patient was a schoolgirl, 12 years of age. She was seen by Dr. Dubs within an hour of the accident. A mere glance sufficed to make a diagnosis of fracture of the right femur in the middle third, as the deformity was pronounced. The patient was put upon a couch, and gentle but firm traction applied to the leg. This was continued for two or three minutes, and sufficed to reduce the deformity and to relieve the pain. It was an oblique fracture of the middle third of the femur. Though easily reduced, there was a marked tendency towards shortening. However, the patient was young; crepitation was good along the whole line of fracture, so that there was every reason for kind union, if only an average amount of proper care were taken. Correct extension was the main requirement to be met. He determined to try the ambulatory method. In the ambulatory method chosen, the weight of the body on the side of the fracture rests upon the ischial tuberosity, the fractured leg hanging free in full extension. When desired, this can be combined with traction upon the fractured leg.

The author described the Thomas splint for this method of treating fractures of the femur. He also referred to the splints of Hessing and to that of P. Bruns, and stated that some surgeons successfully treated fractures of the femur of the middle or lower third in the ambulatory manner by means of plaster casts. The most prominent of these were Tillmans, Korsch, Albers, and Dolinger.

The author found that the ambulatory pneumatic splint answered the requirements of this case very well, in that it embodied all the essential ideas of other methods, and carried them out better than did any one of them. He described the application of this splint, and said it was applied to his patient several hours after the accident took place. At the end of two weeks and five days the patient was allowed to get up and walk about with crutches, elastic traction still being applied. At the end of four weeks and five days, traction was dispensed with. Five weeks and two days after the accident the patient was allowed to discard the crutches most of the time. Eight weeks after the accident, the splint was removed altogether. The result obtained was an excellent one, as could be seen by the Roentgenographs and by examination of the patient.

At no time was an anesthetic used. It might be desirable, even necessary, in some cases,— in the very fat, the very muscular, in cases of compound fracture, etc. Still, by this method traction of great power could be obtained so easily and maintained so readily that the muscles were soon overcome without pain to the patient. By means of

the extension apparatus, bone could be set with little additional manipulation. If, when the correct position had been obtained, good crepitus was felt along the whole line of fracture, a correct result might be assuredly expected, provided this position was maintained. By the proper adjustment of the lateral pads and the lower plate, this could be done. In his case this was successfully accomplished, as the Roentgenograph proved, even though it was an oblique fracture.

Wherever there was a tendency to lateral deviation, the counter-pressure could be accurately applied at any place and in any direction by means of the lateral pad.

The whole extremity was exposed to inspection with a minimum of trouble, thus enabling the surgeon to control the position of the parts and to correct it, if necessary, without discomfort to the patient. If desired, the patient could be taken to the laboratory and a Roentgenograph obtained. Furthermore, friction could be applied to the limb daily, which was a great boon to the patient.

The author's experience with this case would embolden him to allow the next patient to get up and walk about with crutches as soon as the reactionary swelling had disappeared. It appeared to him that the position of the leg would be enhanced when the patient put the weight of the body upon the splint. The leg suspended from the ischial tuberosity was subject to auto-extension, one might say, in that the part of the limb below the fracture acted as an extending weight. With properly guiding lateral pressure, the position assumed by the leg while walking was quite natural. He compared the treatment of fracture of the femur by this ambulatory method with that of fracture of the shaft of the humerus, by means of an attached weight, which might also be ambulatory. Indeed, the favorable results he obtained by treating fractures of the humerus by this method encouraged him to adopt a similar method for this fracture of the femur.

Pressure was applied to the ischial tuberosity, to tissues adapted by nature to pressure, so that decubitus was not to be feared.

The helplessness of the patient and the tediousness and dangers of the dorsal position were avoided. He was convinced that the time of healing was shortened, in that the application of friction, massage, and the use of the limb, protected by the splint, not only prevented the atrophy which accompanied the recumbent treatment, but promoted the trophic condition of the affected part just as similar procedures would in any other like case.

His experience with this case convinced him that these results could be vastly improved upon by the intelligent use of the ambulatory method in suitable cases. The results obtained by the ambulatory treatment of fractures of the femur by the use of this splint were bound to be satisfactory, if only ordinary care was given the case, provided that the care was correct and that the patient was one of average intelligence. The results were necessarily satisfactory, because the continuous inspection to which the limb was exposed must promptly disclose to the surgeon any deviation from the desirable and demanded immediate correction.

The Roentgen Rays in the Diagnosis and Treatment of Fractures

Dr. Joseph F. Smith said that the Roentgen method had given much new information and had corrected many old conceptions, especially in the following lines:

1. *The Pathological Anatomy.*—Many of the older classifications of fractures had been shown to be erroneous, and new forms and variations had been definitely established. Some of the forms either described as rare or not described at all, as, for instance, fracture of the styloid process in Colles's fracture, or fracture of the carpal or metacarpal bones, were shown, by the employment of X-rays, to be of common occurrence. Many injuries formerly described as sprains, especially those occurring about the ankle-joint, could now be demonstrated to be fractures of the tips of one or both malleoli. On the other hand, some of the classic forms described in the text-books were shown to be of rare occurrence, and many injuries heretofore recognized as dislocations could now be shown to be dislocations complicated by fractures. This condition was frequently found in the injuries invading the shoulder and elbow joints. The exact determination of the finer structure of fractures could not be made out by any other method of investigation with any degree of certainty comparable to that obtained by the use of X-rays. The direction of lines of fracture, the degree of comminution, the number and size of loose fragments, could not be determined with any degree of certainty by the older methods, even by the most skillful surgeons. The use of X-rays enabled us to study the gross pathological anatomy of the bones in the living patient immediately after the injury. The advantages of this method of study over the study of post-mortem specimens obtained years after the injury had healed, or by the dissection of injuries produced artifically upon cadavers, must be apparent to all.

2. *Diagnosis.*— The Roentgen method offered a means of obtaining exact and accurate informa-

tion concerning the number, direction, and character of fractures, as well as the exact relative location and position of the fragments without the necessity of painful and harmful additional trauma from manipulation or the dangers of anesthesia. Even under anesthesia, and with any amount of manipulation, the greatest mistakes were often made, even by those who had had extensive experience in dealing with these lesions. The skiagraphs furnished a series of permanent records of the exact conditions present in actual fractures produced in the ordinary manner upon living patients. A collection of some hundreds of such plates from the larger hospitals treating large numbers of fractures would furnish the most reliable statistics from which to determine the relative frequency of fractures of different bones, and a series of lantern slides made from such a collection of plates would be of the greatest value to the teaching of this subject to students and practitioners.

3. *So-called Fallacies of the Roentgen Method.*—It was well known that the X-rays produced by a vacuum tube spread in all directions from a point on the anticathode. Since the distance at which we were able to utilize the rays for practical purposes was not more than a few feet at most, it happened that practically none of the rays were parallel, as were the rays from the sun or some other distant luminous body. This fact made possible the production of distorted images by placing the object in the outer portion of the field of illumination, by placing the tube too near the object, or by placing the plate at an angle with the anticathode. When, however, the tube was placed at a distance of two or three feet, and the object brought near the plate, which was placed at a right angle to a perpendicular from the luminous point on the anticathode, the element of distortion was removed, and the image upon the plate represented the exact condition present. In the early days of the X-ray, when tubes of poor pentration were used, it was necessary to place the tube very near the object in order to secure a sufficient penetration. This resulted in great distortion in the size and location of objects within the field of illumination. Some surgeons, who had not followed the developments of the Roentgen method, still insisted that the X-ray lied when they looked at the skiagraph of a fracture after they had reduced it and found extensive overlapping, marked angularity at the seat of fracture, or wide separation of the fragments. Unfortunately, this somnolent consolation could be theirs no longer. The accuracy of the skiagraph taken by the present improved methods was not a matter of surgical opinion, but a scientific and demonstrable fact, and the sooner men came to realize that the skiagraph was capable of demonstrating the *exact* condition present, without making any allowance for "exaggeration," as they called it, the better would they handle their fracture cases.

4. *Treatment of Fractures.*—The X-ray was of great value in the treatment of fractures, not as a therapeutic agent, but as a means of ascertaining the perfection with which reduction had been accomplished and the extent to which it was maintained by the appliances in use. After a plaster cast had been applied or extension apparatus put on, the exact position and relation of the fragments could be ascertained by means of a skiagraph taken with the dressings in place, without pain or inconvenience to the patient, and without disturbing the dressings. Thus the surgeon had a check upon his method, instead of working in the dark and trusting to luck that reduction had been accomplished and maintained.

In complicated and comminuted fractures it was possible to ascertain the extent of the comminution and to determine from the size and location of the fragments the possibility of wiring or otherwise approximating the fractured surfaces.

5. *Special Fractures.*—The fractures of the long bones were most easily demonstrated accurately by the X-ray. However, by means of plates taken in two or more directions, fractures of many of the short bones, such as those of the carpus and tarsus, might be easily demonstrated. Fractures of the pelvis were more difficult, because of the fact that in most positions we have the shadow of one side superimposed upon the shadow of the other. In some instances, when there was a slight displacement, the condition was readily demonstrated. In a fair percentage of cases one would be able to demonstrate satisfactorily either the line of fracture, the extent of displacement, or both, in fractures of the bony pelvis.

Fractures of the bones of the face and skull were more difficult of demonstration, and, except in cases where there was considerable depression or displacement, the X-ray would not be of great help, because of the difficulty of getting only one side.

Fractures of the spine would be demonstrable in a fair percentage of cases, either by a line of fracture more or less irregular, a splitting and shortening of the bodies of the vertebræ, or a slight displacement with moderate angular deformity.

In the injuries of the shoulders and elbows, we had to deal in a large percentage of the cases with complicated conditions, consisting of a combination of more or less extensive fractures with complete or partial dislocation. It was in these injuries that with the ordinary means of diagnosis the sur-

geon was working in the dark, and that the exact condition with which he had to deal could be so perfectly demonstrated by means of the X-ray.

In children the difficulty of making a differential diagnosis between fracture and epiphysial separation frequently presented itself, especially in injuries involving the wrist, elbow, shoulder, hip, and knee. In these cases, before the epiphysis had united with the shaft the skiagraph would show a more or less complete separation between epiphysis and shaft, owing to the fact that cartilage casts a relatively faint shadow and the mistake of diagnosing a separation of the epiphysis in a normal joint was easily made. It was only by securing skiagraphs of the injured joint in at least two directions, and making careful comparisons with corresponding skiagraphs of the same joint on the opposite side and noting the relative degree of separation and dislocation, that a correct diagnosis could be made.

The Use of Molded Plaster Splints

Dr. H. P. Kirtley said that the use of molded plaster-of-Paris splints was becoming wider and more frequent every year. The advantages of these splints in simple fractures were, that one could watch the progress of the callus, and would not leave the cast on any longer than he should, and he would not have to take it off too soon, as in those cases that frequently had non-union or very apparent good union with the X-ray, yet if the cast was taken off the bone would begin to bend. Also, so far as comfort was concerned, the cast might be taken off from time to time, the limb rubbed with alcohol, and the cast replaced with no disturbance of the fragments. Another advantage was that the splint could be put on at once, instead of a fracture-box, and an ice-bag put over the site of fracture. If the limb swelled, the patient did not complain of pain, and if the swelling was not great, the patient received no discomfort whatever, and the cast might be left on in the course of healing.

In compound fractures the advantages of molded plaster-of-Paris splints were obvious. The wound could be exposed and could be handled, and, if necessary, irrigated.

Dr. Kirtley then demonstrated how these molded plaster-of-Paris splints were applied by the internes in one of the hospitals.

The best material to use was crinolin, which costs five cents a yard, and could be purchased in large quantities. The next best thing was wide-mesh gauze, which costs two and a quarter cents a yard. Specimens of these different articles were exhibited.

He showed a variety of molded plaster-of-Paris splints, which were adapted to almost any case or kind of fracture.

Other advantages of this splint were, that it fits the patient; that it is light and durable.

Discussion

Dr. David J. Doherty reported the case of a woman, 68 years of age, frail, poor circulation, and quite delicate. Patient, in getting off a street-car, fell and injured her hip. For two weeks the woman labored under the impression that she sustained merely a contusion, and walked around. When he saw her and examined her, he was sure there was a fracture at the hip-joint. A more critical examination confirmed his previous examination that this diagnosis was correct.

As regards treatment, he used the ambulatory pneumatic splint, as he feared hypostatic pneumonia, bed-sores, etc., that came from long recumbency. His experience with this splint was very satisfactory. Among the advantages of this splint was that the woman was put on her feet and could support herself standing. In this way there was a good and free circulation. Another advantage was that the dangers of hypostatic pneumonia and bed-sores were overcome.

Dr. Daniel N. Eisendrath stated that his experience with the Thomas-Ridlon hip-splint had been that it combined many of the properties of the ambulatory splint and had some advantages. The Thomas-Ridlon hip-splint was especially adapted to the treatment of fractures of the neck of the femur in elderly people, or in people who were stout and who would be subjected to great hardship to be confined to bed. He described the Thomas-Ridlon hip-splint, and said that he had used it in a number of cases with excellent results. He referred to a splint which was used at the Cook County Hospital, much cheaper than the Thomas-Ridlon splint, yet which, for all practical purposes, was as useful as the ambulatory splint in fractures of the shaft and neck of the femur.

He pointed out, in connection with Dr. Smith's paper, that a great many skiagraphs do not so much exaggerate the fracture itself in the direction in which they were taken, as they exaggerated the deformity in the mind of the patient and sometimes in the mind of the physician, whereas by palpation one could scarcely feel anything. The X-ray would at times give an exaggerated idea of the extent of deformity of a fracture. He hoped the time would come when skiagraphs would be taken systematically at all ages,— that is, beginning with children at the age of two or three months, and extending up to the time when ossification was complete.

The use of molded plaster-of-Paris splints had rendered the treatment of fractures at the Cook County Hospital very much easier than before. In this institution there were on an average between seventy-five and one hundred cases of fracture under treatment. These splints were easily made, and he thought every general practitioner ought to know how to make them. They were likewise useful in the treatment of fractures of the upper extremities.

He called attention to the point that the general practitioner frequently overlooked the diagnosis of pathological fractures. Now and then cases of fracture came up that had been treated in vain from four to six weeks, without union having taken place. To illustrate the occurrence of pathological fractures, he mentioned a fracture which occurred in a patient who had been operated upon two years previously for a malignant tumor. Recently, at the Cook County Hospital, a patient had been treated for some weeks for a supracondyloid fracture occurring in locomotor ataxia, and after the patient had been treated with iodide of potassium, callus formed and healing took place.

DR. CHARLES DAVISON stated that almost any kind of splint, if intelligently applied and carefully worn, would give good results. The result obtained in Dr. Dubs's case was excellent. He thought it was as good a result as could be obtained by any splint. But any of the recognized practical splints in the hands of such men, carefully applied and intelligently looked after, would produce satisfactory results. He was not enthusiastic over the ambulatory splint. He thought, however, that the ambulatory splint had a place in surgery in the treatment of fractures, but that it was limited. In fractures of the femur it was limited to those cases which were required to be gotten out of bed at once because of other complications. For instance, it was necessary, in the case of old people, to get them out of bed as soon as possible, to guard against the development of hypostatic pneumonia or bedsores. It was applicable to any fracture of the femur, if union had progressed far enough, so that the fragments would not separate, or further extension was not required.

As to the X-ray, it should be the routine work of every surgeon to treat fractures on the X-ray picture as a matter of record, taken in two directions, before and after reduction, and as soon after the limb is put up in a splint as practicable.

Molded plaster-of-Paris splints were ideal in some cases. They filled so many indications and could be molded accurately and easily. But they were limited in application. For fractures of the humerus and injuries of the elbow, they were ideal, as they could be easily molded to the part. Where the injury was below the elbow, he did not think they should be used.

DR. WILLIAM FULLER said a phase of the subject which particularly interested him was that so-called simple or unopen fractures presented obstacles to reduction. Surgeons met with many such fractures, and it was not possible to treat them successfully with any form of splint which had been described. The only means by which such fractures could be treated was by operating upon them. There were two very good reasons for this: 1. We could relieve the fractured bone or limb of a great deal of hemorrhage, which was almost always present in such a fracture. 2. We could remove from between the ends of the bone torn muscle and fascia, which were the means, probably, of preventing reduction of the bone. We were then not only able to replace the ends of the bone approximately in the position they would likely remain with any kind of splint, but were able to remove blood-clot, do away with subsequent swelling which would otherwise occur, and therefore apply some form of splint which was very much tighter, and which would be more likely to hold the fragments in apposition. Unopen fractures presenting obstacles to reduction should be cut down upon and the fragments wired.

DR. EDWARD H. OCHSNER was glad to hear that skiagraphs could be satisfactorily taken through plaster-of-Paris dressings.

While plaster-of-Paris splints were satisfactory, he thought they were too heavy, and if the surgeon could, in making these splints, cover them subsequently with gluten bandages, they could be made just as strong with one half the weight, and for a patient who had to go up and down stairs it made quite a difference whether he should carry four or two pounds.

He dissented from the view expressed by Dr. Eisendrath, who recommended passive motion by a professional masseur in fractures. He said there might be exceptional cases in which passive motion was indicated, but he had yet to see a case in which he would advise it in fractures near joints.

DR. RICHARD M. FLETCHER said that during four years' experience in the medical corps of the army he treated seventy-five cases of fractures, and the plan he adopted was to get the patients out of bed as soon as possible in all cases, except fractures of the femur, putting them as soon as possible in wheel-chairs and getting them out onto the verandas of the hospital. He found he could do this much quicker by putting the fracture in a permanent dressing and treating it for the first forty-eight or seventy-two hours with constant irrigation.

This was particularly true of fractures of the lower extremities, or those near joints — Pott's fractures, and fractures of the tibiæ.

He had almost discarded the use of plaster of Paris for silicate of soda in the treatment of fractures. Silicate of soda was not generally used by the profession. He mentioned four cases of fractures of the lower extremities in which the limbs had been put up in silicate of soda dressings, and the results obtained were excellent.

Dr. Arthur B. Hosmer said he saw no objection, in a transverse fracture of the lower third, or middle of the femur, in making the case ambulatory in a comparatively few days.

In fractures similar to those that were made in correcting knock-knee in the lower part of the femur, just below the condyles, where a distinct transverse fracture was made, it was not necessary to have any form of extension.

As to the use of the X-ray, he was glad to hear Dr. Smith emphasize the importance, in all fracture cases, of taking two views of the fracture, as it was important to determine the exact direction of the fracture, and, after correction had been made, to determine whether or not there was full reduction of the fragments.

He referred to the inefficiency and uncertainty of fluoroscopic examinations in fractures of the hands or feet.

As to the use of molded plaster-of-Paris splints, while they were admirable in certain cases, in the average fracture of the bones of the forearm or of the leg, or even thigh, he did not see any particular advantage in using them.

Dr. Edwin W. Ryerson expressed the conviction that every patient with a fracture of the neck of the femur should be turned over on the face at least two or three times a week, and the knee passively bent to the extreme limit of flexion. This should be done regularly as long as the patient is having traction or immobilization of the knee, in case it be an old patient. In children, immobilization should be practised up to two or three years, as in cases of tuberculosis of the hip-joint or knee-joint. Old people would get stiff knees, in spite of what the surgeon did, unless they were anesthetized and the adhesions, if present, broken up, or the stiffness of the muscles overcome. By so doing one would gain the confidence of the patients and afford them much comfort.

With regard to operating on closed fractures, unless it was absolutely imperative he was unalterably opposed to it. He looked upon it as meddlesome surgery, unless there was some other way to deal with the fracture. He never used wire in any form for uniting fragments, but said that chromicized catgut would answer every need. An objection to silver wire was taking it out afterwards,— after it had caused trouble,— and one was putting a foreign body in a place where it should not be.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF SURGERY

UNDER THE CHARGE OF

JOHN B. MURPHY, M. D. — E. WYLLYS ANDREWS, M D.
FREDERIC A. BESLEY, M. D — WM. R. CUBBINS, M. D.

PEPTIC ULCER AFTER GASTROENTEROSTOMY, WITH THE FORMATION OF GASTROCOLIC AND JEJUNOCOLIC FISTULÆ, COMPLETE OBLITERATION OF THE GASTROENTEROANASTOMOSIS. Kaufman.

The case reported by Kaufman of New York is another example of one of the possible post-operative complications after gastroenterostomy for a benign lesion of the stomach. Clinically, the patient exhibited definite signs of a chronic gastric ulcer associated with hyperacidity, motoric insufficiency, and a moderate amount of stenosis. The patient was a male, aged 44; gastric symptoms had been present three years; during this time there had been three definite hemorrhages, and one year after the beginning of the symptoms an acute attack, suggesting perforation of the stomach, in which general peritonitis had been prevented by adhesions. In the latter part of the disease there was a distinctly palpable pyloric mass. Temporary improvements had been accomplished on three occasions by medical treatment.

At the operation in December, 1901, about three years and three months before his death, a retrocolic posterior gastroenterostomy was done with an additional enteroanastomosis by Lange. At this operation the pylorus was indurated and its posterior wall adherent; on the anterior surface of the stomach, near the pylorus, white scars were seen, one of which was depressed, and suggested a site for the previous perforation. The anastomoses were performed with silk. For three months after an uneventful convalescence, the patient was completely relieved of all his previous symptoms, and gained 25 pounds in weight. At this time there was a return of the gastric symptoms, at first mild and intermittent; six months after operation, the stomach was found to be dilated, and there was hyperacidity. Eight months after the operation the patient had cerebral symptoms in addition to his gastric discomforts, and was treated for syphilis with the disappearance of the cerebral symptoms. About two years after the operation, when the gastric symptoms had reached a severity equal to that present before operation, there was evidence of fecal material in the gastric contents. Irrigations of the stomach and large bowel demonstrated the passage of the contents of the colon into the stomach, but not of the gastric secretion into the colon. From this time up to March, 1905, the patient's local and general condition grew worse.

The second operation was performed by Gerster. The transverse colon was adherent to the stomach, posterior wall, and to the jejunum behind. Through these adhesions there was a fistulous tract lined by mucous membrane. With great difficulty the intestines were separated and the four openings closed. The colon, after the suture of its two openings, was so stenosed that anastomosis was performed between the ascending colon and the sigmoid with the Murphy button. The patient, after this operation, did well for six days. Symptoms of perforation were followed by immediate laparotomy; a perforation was found, due to necrosis, about the Murphy button. At the autopsy it was demonstrated that the intestine sutured to the stomach at the first operation over four years ago had completely separated, and there was no evidence of the gastroenterostomy to be found. The opening of the enteroanastomosis was patent, but small.

Kaufman explains the findings in the following manner: The return of the patient's gastric symptoms was due to the formation of a peptic ulcer in the posterior wall of the stomach, near the gastroenterostomy. This ulcer perforated into the colon, which had become adherent; opposite this pathological gastrocolostomy a second peptic ulcer formed in the colon, which again peforated into the jejunum, which had also become adherent to the colon. There was a spur of mucous membrane in the gastrocolic fistula, which prevented leakage from the stomach into the colon like a valve, but allowed the flow of fecal contents into

the stomach. The area on the jejunum which surrounded the perforation of the colon had become a diverticulum; this Kaufman explains by the traction of adhesions. At the first operation and at the autopsy obstruction of the pylorus was not found.

Kaufman does not attempt to explain the closure of the gastroenterostomy and the separation of the jejunum from the stomach.

Kaufman, in comparing his case with the collective review by Tiegel of peptic ulcer of the jejunum after gastroenterostomy, finds no similar observation. In one case from Czerny's clinic there was an ulcer in the stomach, which had perforated into the colon, but the gastroenterostomy opening was patent. Perforation into the colon from a gastric ulcer is not a very unusual pathological finding. Kaufman's observation is therefore unique, chiefly on account of the disappearance of all evidence of gastroenterostomy and the double perforation.— *Mittheilungen a. d. Grenzgeb.*, 1905, vol. xv, p. 151. JOSEPH C. BLOODGOOD.

PEPTIC ULCER OF THE JEJUNUM AFER GASTROENTEROSTOMY. Tiegel.

This contribution gives us the first complete and detailed summary of all the cases reported in the literature of this post-operative complication. Tiegel gives the histories of 22 cases, of which 6 were observed in von Mikulicz's clinic in Breslau. The first observation was reported in 1899 by Braun. In the German Surgical Congress of 1903, Brodnitz, in reporting his observation, discusses briefly 14 other observations from the literature. In these two articles I am unable to find a single case reported by English, French, or American surgeons. Moynihan, in his book on abdominal operations, just published (page 175), states that he has observed one case in which death resulted from perforation, and that there are four reported cases in which second operations were performed. I am unable to find any references to the literature, except those of German surgeons collected by Tiegel. In view of the large number of gastroenterostomies performed in this country, it is difficult to understand the absence of recorded cases of peptic ulcers following it.

Tiegel summarizes these 26 cases somewhat as follows: The majority of the patients were of the male sex and over 30 years of age, the youngest an infant of four months (von Mikulicz's case). The stomach lesion in every case was benign, as a rule, associated with stenosis and dilatation of the stomach: one case of congenital stenosis; one in which the ulcer was in the duodenum. Examination of the stomach contents before the first operation of gastroenterostomy was recorded in only a few cases. In a few there was absence of HC1; in perhaps the majority, increased hyperacidity. In a few cases, examination of the stomach contents was made after the gastroenterostomy and before the symptoms of secondary ulcer. In these few cases, also, both instances of hyperacidity and diminished acidity were found. This complication, therefore, may follow when there is no hyperacidity.

Pathologically, the ulcer resembles the peptic ulcer of the stomach or duodenum; there is first a hemorrhagic effusion into the mucous membrane followed by digestive necrosis. Until the lesion excites inflammatory changes in the peritoneum at the base of the ulcer, or especially a local peritonitis of tissues near the peritoneal base, there are no symptoms. For this reason there may be a perforation of the ulcer without previous symptoms. When the base of the ulcer is walled off by peritoneal adhesions before perforation, the symptoms are those of a localized area of inflammation in the abdominal cavity — pain, tenderness, and in some instances tumor formation. In the walled-off cases, perforation may take place into a hollow viscus through the abdominal wall with the formation of a fistula, or the perforation may give rise to a localized abscess in the region of the ulcer.

Clinically, the cases divide themselves into two groups. In the first there are absolutely no symptoms until suddenly the patient exhibits the symptom-complex of a perforative peritonitis. Eight of the 26 cases belong to this group. Two recovered (Goepel's cases) after immediate laparotomy and suture. In Kocher's case the symptoms of perforation were considered due to appendicitis, and the appendix removed: only at the autopsy was the correct diagnosis made. In the remaining cases the symptoms were subcute. As a rule, they are situated to the left, and lower than the usual local signs of a gastric ulcer; frequently an inflammatory tumor can be palpated in this area.

The symptoms of this secondary ulcer have appeared, after the primary operation, between ten days and eight years; ten cases within the first year, five between the first and second, five between the second and eighth year. This observation is a very important one, and must be borne in mind in estimatingt he ultimate results of a gastroenterostomy.

Treatment.— In the first group, immediate operation with closure of the perforation is indicated. In the second group, according to Tiegel, secondary operations have been unsuccessful, and unless indicated by special symptoms like obstruction or fistula, medical treatment gives better results.

Method of Procedure in the Primary Operation. — In 16 cases the method of anastomosis was anterior; in 7 of these, an additional enteroanastomosis (one of these a Roux); in 5 cases the anastomosis was retrocolic and posterior, but with a longer intestinal loop than that used at the present time, and not the transverse position of the intestinal loop. The secondary ulcer in 10 instances was near the gastroenterostomy opening, in 1, near the opening of the enteroanastomosis; in 10 cases it was in the jejunum, separated 1 to 7 cm. from the gastroenterostomy opening; in 3 cases the ulcers were multiple; in 7 cases there were also ulcers of the stomach.

From this critical summary Tiegel naturally concludes that one should hesitate to perform gastroenterostomy for a benign lesion of the stomach, unless it is specially indicated; if possible, an anastomosis at the pylorus, like Finney's operation, is preferred. So far, no secondary ulcers have been observed after operations in the neighborhood of the pylorus. When gastroenterostomy is indicated, it should be done posteriorly, retrocolic, with a transverse position of the intestine. The presence or absence of an enteroanastomosis apparently has no influence for or against the formation of a peptic ulcer.

The best illustration of a peptic ulcer has been furnished by Watts (*Johns Hopkins Hospital Bulletin*, July, 1903, vol. xiv, p. 191), and *International Clinics*, 1904, vol. i, 14th series, April, p. 255.— *Mittheilungen a. d. Grenzgeb.*, 1905, vol. xiii, p. 897.—JOSEPH C. BLOODGOOD.

ON POST-OPERATIVE ARTERIO-MESENTERICAL CLOSURE OF THE INTESTINE AT THE DUODENOJEJUNAL BORDER, AND ITS RELATION TO ACUTE DILATATION OF THE STOMACH. By Hugo Zade.

Acute dilatation of the stomach is an unusual lesion and a rare post-operative complication. Zade, in reporting an observation from Garre's clinic in Königsberg, is interested chiefly in the mechanism of this obstruction. He claims that in the majority of cases there is a chronic dilatation of the stomach, and that the acute dilatation is the result of the anesthesia, more especially chloroform. The huge stomach presses the small intestines into the pelvis. This combination produces traction on the mesentery, and the duodenum, as it joins the jejunum beneath the anterior mesenteric artery, is completely occluded; that is, the dilatation of the stomach is a primary condition, and kinking of the duodenum beneath the mesentery a secondary one. In view of this conclusion, Zade suggests the term " gastromesenteric ileus."

This authority also claims that there is a physiological and partial obstruction at the duodenojejunal junction which retains the contents of the stomach after they have passed into the duodenum until this partially digested material is thoroughly mixed with the secretions of the duodenum.

This view of Zade is not shared by all of the previous contributors to this subject. Irrespective of the exact mechanism of the lesion, it is very important that its possibility should be borne in mind. We should attempt to find out a preventive treatment, if possible; to learn to recognize it early, clinically, when we cannot prevent it; and to study means to accomplish a successful treatment. So far, in the majority of cases it has not been recognized clinically, and as but few patients have recovered, the nature of the lesion has become known only at autopsy. The case reported by Zade was a female 32 years of age, who had had symptoms of ulcer of the stomach for 18 months. The recent symptoms and examination suggested a carcinoma secondary to ulcer. At the operation the stomach was very much dilated, and the indurated tumor at the pylorus was adherent to the pancreas. The glands in the neighborhood of the tumor had the appearance of metastasis. A posterior retrocolic gastroenterostomy was performed. Within 24 hours after operation the patient was restless and nauseated, and there was some distension in the upper abdominal zone. Forty-eight hours after operation the patient complained of intense pain in the epigastrium, which was still distended, and the muscles were tense. At this time she vomited a large quantity of bile-stained gastric contents, and the stomach-tube removed one liter more of the same fluid. A few hours later the patient went into collapse, and died on the third day. At the autopsy the greater curvature of the dilated stomach extended to the pubes. The duodenum was dilated up to the mesentery; the jejunum and small intestines on the other side were collapsed. Unfortunately, there is no note whether the small intestines were in the pelvis. Zade concludes that they must have been. The gastroenterostomy was apparently healed, and may have had some etiological relation to the kinking at the mesenteric junction.

Zade then discusses the different views on the etiology of this condition with reference to the best literature. As a complication it has been observed chiefly after laparotomies, more especially after operations on the gall-bladder and the ducts. The lesion, however, has occurred after placing a kyphotic patient in a plaster cast without anesthesia, and in a few operations not on the abdomen under anesthesia.

As to treatment, one should look to the condition of the stomach before operation. Patients with chronic dilatation of the stomach should, if possible, have a preliminary treatment of restricted diet and stomach irrigation, and after operation the stomach should be irrigated,— that is, means should be employed to prevent gastric distension. As a rule, the complication comes on shortly after operation; it may be delayed some ten days. The vomiting differs from that ordinarily observed after anesthesia, on account of copiousness, and its dark-brown color is due to the presence of bile in the secretion of the duodenum. It has the fecal color, but not the odor. This vomiting is associated with marked depression. If the patient is not relieved, death takes place quickly. When these symptoms manifest themselves, Zade recommends Schnitzler's treatment. The stomach is washed out, the patient is put in a knee-elbow position every two hours for fifteen minutes. The object of this is to change the position of the stomach and small intestines by gravity and relax the tension on the mesentery. In the interval the patient lies on the belly and later in the left lateral position. In lighter cases the symptoms have subsided after this treatment; if the symptoms are not relieved in 24 hours, operation should be resorted to. Zade recommends jejunostomy. So far the operative treatment has rarely been successful.— *Beitr. z. Klin. Chir.*, 1905, vol. xlvi, p. 388.

JOSEPH C. BLOODGOOD.

THE VAPOR METHOD OF ANESTHESIA. By James Tayloe Gwathmey, M. D.

The writer discusses the subject of general anesthesia, and describes the Junker, the Harcourt, and the Braum inhalers.

He then gives a detailed description of an inhaler as devised by himself, which is a modification of the Hewitt inhaler. The advantage claimed for this inhaler is that the supply of ogyxen or air can be increased without increasing the amount of the anesthetic. A strong plea is made in favor of the vapor method.

The advantages of this form of anesthesia over other methods are given as follows:

1. The induction stage is very pleasant (comparatively) for the patient.

2. A second advantage of the vapor method of anesthesia is the fact that excitement is usually absent, or so very slight that it is unobjectionable, even in private practice.

3. In the surgical stage, the patient's breathing is regular and natural. The lid reflex is never entirely abolished, nor do we have the stertor or snore, or the mucous râle, even when giving pure ether. We have complete relaxation, without the slow pulse of chloroform (as usually administered), or the billowy breathing and rapid-bounding pulse of ether. The breathing and pulse are usually normal throughout the administration, except for fluctuations that may accompany the surgical procedure. In fact, the breathing is so natural that in the majority of cases it is unnecessary to hold the jaw forward. This method will appeal at once to those who prefer, or who have been in the habit of using, the drop method, as the principle is the same, the dosage more accurate, and the narcosis more even. It is also safer, even in the hands of the occasional or inexperienced anesthetist.

4. The small amount of the anesthetic used. As with my mask it is impossible to determine accurately the exact amount consumed by the patient, no figures will be given as rough estimates; but the total amount used, in spite of much waste, is remarkably small, and has been commented upon by many surgeons.

5. In the majority of cases, absence of unpleasant after-effects. This includes scalding the face with the anesthetic, which is an impossibility with this method.

6. The technic can be acquired much more rapidly than any other anesthetizing method.

7. As we know, approximately, what percentage a patient is getting, a continual narcosis is maintained without any danger whatever to the patient. An intermitting narcosis, which is wrong in principle, is thus always avoided.

The claim is made that oxygen is safer than air when used in the vapor mixture.

A number of experiments on lower animals seemed to establish this fact. These experiments also showed that in cases of suspended animation the respiratory center was always the first to be affected.—*Medical Record*, Oct. 14, 1905.

THE CHOICE OF METHOD IN OPERATING UPON THE HYPERTROPHIED PROSTATE. By Wiley Meyer, M. D.

Under the above title the author presented an exhaustive paper to the Chicago Medical Society. Several characteristic cases are cited to illustrate the advantages of the selection of the method most adaptable to the condition of the gland.

A detailed description of the technic employed in the suprapubic operation is given.

The following summary is deducted:

1. We have to-day three useful methods for the operative relief to prostatic obstruction; i. e., suprapubic and perineal prostatotomy (Bottini's operation).

2. Unassailable proof has been furnished to

show that all three methods deserve to be recognized as standard procedures, each being capable of bringing permanent relief.

3. Wherever the patient's condition, irrespective of age, seems to warrant it, prostatectomy should be done, since the total removal of the mechanical obstruction naturally represents the most surgical procedure.

4. While it is true that either method, perineal or suprapubic, can be successfully employed to the exclusion of the other in removing the hypertrophied prostate gland, it certainly means facilitating our work, and is in the interest of the patient, if we use both procedures, choosing in each instance the one that seems best suited to the particular case. The selection of the route, on strict indication, is not an easy matter at present. Further reports by surgeons practising both procedures are needed to decide the question. Both methods are excellent and useful ones. The choice up to the present time is largely a matter of individual inclination. Perhaps we are warranted in saying, on basis of our present experience:

a. Glands palpable per rectum, and rising not far from the sphincter ani muscle, can be advantageously attacked from below.

b. If situated higher up, and if the growth projects well back into the bladder, they should be enucleated from above, all the more if the cystoscope has shown the presence of a median lobe.

c. A hypertrophy of soft character in the early stages, so frequently found to be made up of a number of smaller nodules, each of which can be enucleated by itself, is best attacked from below.

d. In the 33 per cent of cases in which no tumor is palpaple per rectum, but in which vesical enlargement is recognized by the residual urine or total retention, and seen distinctly by means of the cystoscope to be the obstructing cause, the suprapubic route deserves the preference.

e. If the enlargement be complicated by a vesical calculus or calculi of larger dimensions, too large to be easily extracted through the dilated internal sphincter muscle, the suprapubic route is indicated.

f. In patients with a very foul urine, where immediate drainage of the bladder is imperative, the suprapubic incision should be chosen. The gland may be removed at a second sitting.

g. The comparatively frequent appearance of carcinoma of the prostate may prove to become an important factor in deciding in favor of complete removal of the gland from above.

5. The question of the preservation of sexual power is an important one. Further experience and investigation are needed to enable us to definitely determine whether there is any difference in results as to this point between the two methods of operation. As it seems today, the suprapubic operation is superior in this respect to the perineal method, even though in the latter the portion of the gland immediately surrounding the prostatic urethra and the ejaculatory ducts have been preserved. If future statistics should prove that with suprapubic prostatectomy the sexual function is more frequently preserved than with the perineal procedure, this must necessarily decide the choice of route in patients in whom this point has still to be considered.

6. If operation with the knife be refused, or there be contra-indications to such interventions, Bottini's operation is in order.

7. Only if this operation, too, be refused or impossible are we justified in relegating a patient to the regular use of the catheter.

8. Cystoscopy is absolutely necessary before doing Bottini's operation; it should also precede perineal prostatectomy in order to enable us to determine the presence or absence of a median lobe and calculi; it may be dispensed with if the suprapubic operation has been decided upon, although a previous, distinct knowledge of intravesical conditions must be welcome to the operator. In that 33 per cent of prostatics who present no enlargement on rectal palpation, the cystoscope alone can establish a distinct and refined diagnosis.

9. The time of operation, at least in the rank and file of prostatics, has come when regular catheterization has become imperative. The catheter should not be intrusted to them for regular use. Well-to-do patients, being in a position to take the time and care necessary for the carrying out of self-catheterization on aseptic principles, may be allowed to do so if opposed to operative intervention.

Another strict indication for operation is persistent severe pains in the perineum, neck of bladder, and glans penis, resisting ordinary treatment.

10. Surgeons should familiarize themselves with perineal and suprapubic prostatectomy, as well as with galvano-caustic prostatotomy (Bottini's operation), in order to be able to do justice to the prostatics intrusting themselves to their care, for no one method of operation can be employed in all cases of prostatic enlargement to the best advantage of the patient. In other words, we must select the operation that suits the case.—*Medical Record*, Oct. 7, 1905.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF GYNECOLOGY

UNDER THE CHARGE OF

J. CLARENCE WEBSTER, M. D. E. C. DUDLEY, M. D.
JOHN C. HOLLISTER, M. D. F. W. LYNCH, M. D.

VAGINAL CYSTS. By Thomas S. Cullen.

The author in this paper tabulates 53 cases of vaginal cysts occurring in the gynecological department of the Johns Hopkins Hospital. A number of the cases (11) have previously been reported by Stokes in an excellent article in 1897. Inasmuch as the etiology is the chief feature of interest in vaginal cysts of moderate size, attention is called to the anatomical structures from which cysts may originate. The anatomy is reviewed under the following headings:

1. The gross and histological anatomy of the normal vagina;
2. The embryonic structures that may persist in the vagina;
3. Changes in the vagina incidental to vaginitis;
4. Changes due to injuries resulting from childbirth;
5. Alterations in the vagina caused by perineal operations;
6. The relation of the urethra to the vagina.

In the consideration of the normal vagina, the author briefly considers the subject of vaginal glands, quoting Hennig and von Preuschen to the effect that they occasionally exist, and reporting two cases as supplementary proof "that vaginal glands exist in a moderate percentage of women." One of the author's specimens was a "small oval gland space lined by one layer of high cylindrical epithelium" (found in proximity to a vaginal cyst). "It closely resembled a cervical gland and was surrounded by a definite inflammatory zone." The author was unable to tell whether the cyst was situated in the anterior or posterior vaginal wall, it having come to the laboratory for routine examination. (This, however, appears to be the same case which Stokes reports under cysts of the lateral wall.)

Observations upon the presence of vaginal glands are always of interest, although at the present time few observers, if any, believe that they normally (i. e., invariably) exist in the vaginal tissue. Waldeyer, Nagel, Pretti, Eppinger, Gebhard, and others have failed to find them, and deny their existence. Indeed, they have been found only in rare instances, and from the evidence before us we may conclude that vaginal glands do not normally exist. Von Preuschen has reported their finding in 4 of 36 cases. He states that they presented a structure similar to the sebaceous glands of the vulva, the resemblance being marked, especially in the glands found in the upper vagina. This, in a measure, was confirmed by Veit, and also by Davidsohn in Landau's clinic, the latter observer considering, however, that they merely represented aberrant cervical glands. Cullen does not enter into discussion of this subject.

Inclusion Cysts, arising from inclusion of the vaginal mucosa, either the result of a perineal tear or perineal operation. They constitute 26 of the 53 cases of the series, and were all situated on the posterior or lateral vaginal wall. All were of small size, ranging to 2.5 cm. in diameter, were lined with 2 to 8 layers of squamous epithelium, and contained fluid in which fat droplets and cholestrin crystals could occasionally be distinguished. Twenty-four of the 26 cases gave a satisfactory history of perineal laceration, which had extended into the rectum in 5 instances. (This group is of great interest when we recall that Nouvel in 1895 stated that "all vaginal cysts have a Wolffian origin.")

Cysts Probably Arising from Vaginal Glands. — "Three cases, possibly four, seem to fall under this category." These are lined with cuboidal or almost flat epithelium. Cullen takes the view that if these were inclusion cysts, they would have been lined with squamous epithelium; or if this had degenerated to leave the deepest layer of cuboidal epithelium, exfoliated squamous epithelium would have been found in the cyst contents. His "most convincing evidence is furnished by the fact that we have two varieties of cysts,— inclusion cysts and those derived from vaginal glands,— lying side by side without evidences of degenerative changes in either."

Cysts of Gartner's Duct.— From the dilatation of the persisting duct we may have single cysts or multiple ones occurring in a single row. Eleven cases are grouped under this heading. Their most common location was in the anterior vaginal wall, just behind the urethral orifice. They are invariably translucent, contain a clear, straw-colored fluid, and for the most part are irregular in form, suggesting that a portion of the duct had not yielded readily to the process of dilatation. The lining of the cyst-wall is a border of cuboidal, cylindrical or almost flat epithelial cells. The largest case of the series was noted in this grouping. It measured 8 by 5 cm.

Vaginal Cysts Arising from Urethral Glands. — Although these are undoubtediy of rare occurrence, the possibility cannot be excluded, and Cullen describes two cases which to him present a histological appearance very similar to, if not identical with, that of the urethra. A third case is included in this grouping, on account of its location, although the author states that the origin might also be ascribed to Gartner's duct.

Unclassified Vaginal Cysts.— Nine cases are grouped under this heading, because the clinical details were so scanty that it was impossible to venture a classification.

All of the cysts reported in this paper were relatively small and gave rise to no symptoms. It is stated that vaginal cysts may, however, attain considerable size.— *Bull. Johns Hopkins Hospital*, vol. xvi, No. 171, June, 1905.

Cancer of the Uterine Cervix: Its Classification and Extension. By John A. Sampson.

The paper calls attention to the great relative frequency of cancer of the cervix, which, according to the author, is five or six times more frequently encountered than cancer of the uterine body. In spite of the rapid growth and great malignancy of this tumor, the author believes that it is curable by radical operation, and that early operative interference should give a large percentage of cures. He believes, moreover, that a small percentage of even the extensive growths may be cured by radical operation.

The material upon which the paper is based is derived from the study of 27 cases of cancer of the uterine cervix, the specimens having been removed by wide excision of the primary growth at operation. In 19 cases of the series the pelvic glands were also included in the resection, 154 individual glands having been encountered and studied. The uterus and parametrium were cut in sagittal and cross-section in each instance, and the growth reconstructed and studied. Charts and diagrams are given to show the various types of growth. Few of the cases had been curetted, and excellent opportunity was afforded to study the natural morphology of the growth, and the changes undergone with the progression of the disease.

Two anatomical groups of the cancers of the uterine cervix are considered: 1. Those arising from the *vaginal portion of the cervix;* and 2. The smaller group, which arises from *within the cervical canal.* These two groups are classified histologically into the *squamous cell carcinoma*, which is the more frequent variety, and into the *cylindrical cell, or adenocarcinoma*, which is much less frequent, but of greater malignancy. Of the author's cases, 24 were squamous cell, 2 were adenocarcinoma, while 1 was of mixed-cell type.

The two histological varieties of the uterine cervix are, in turn, subdivided into groups, according to the morphology of the growth, whether *everting* (i. e., vegetative) or *inverting* (i. e., infiltrating), and the latter whether medullary or scirrhus. The various stages in the life history of the medullary form are considered, and are illustrated by diagrams.

The author believes that the classification of uterine cancer is of importance in studying the clinical manifestations of the disease in the different stages of its development, and the pathological changes upon which the clinical signs depend. The relative malignancy of each group has been determined; thus, the cylindrical cell cancer is more malignant than the squamous cell variety, and the inverting or infiltrating type is of greater malignancy than the everting. "Unfortunately, the diagnosis of the more malignant types is usually more difficult."

Study of the author's specimens showed that the growth extended beyond the uterus in 20 of the 27 cases.

The parametrium was involved either by direct extension or metastases in 17. In 14 cases there was direct extension of the growth from the cervix, either by delicate processes or cancerous mass. Nine cases show metastases to the lymph structure of the parametrium, and in only one of these was cancer found in the lymph-channel itself; in the other 8 the cancer-cells apparently had passed through the lymph-channels without involving them, and had lodged in a lymph node.

Three types of lymph nodes in the parametrium are described, which may be affected by metastases:

1. A large gland occasionally found near the crossing of the ureter and uterine artery.

2. Small glands normally present in the parametrium.

3. Atypical nodes apparently developing in the walls of the main lymphatic channels, and protruding like a sponge into their lumen. These were found in 4 of the 27 cases, and in 3 of the 4 cancer had metatasized to one or more of these nodes.

The author insists upon wide excision of the primary growth in every operation, because the parametrium is so frequently involved by direct extension of fine cancerous threads as well as metastases, *neither of which can be recognized by clinical means.*

Involvement of the pelvic lymph-glands was found in 9 of the 19 cases in which the glands were removed at time of operation, and the author states that in 30 to 50 per cent of operable cases the disease has metastasized to the pelvic lymph nodes. No relation is recognized between the size of the primary growth and the presence or absence of involvment of the pelvic lymph nodes. The primary growth may be small and yet metastases may have already occurred to the pelvic lymph nodes, so it is impossible to tell clinically as to the occurrence of metastasis, for a soft-feeling parametrium may contain cancer and an indurated one may be free from it. The diagnosis as to the condition of a lymph-gland can be arrived at only by the microscope, for a large gland may not be cancerous, while a small one may be, without changing either its size or consistency.

On the other hand, the author believes that 40 per cent of cases may present extensive local growth without involvment of the pelvic lymphatics. Due to this fact we may hope to cure even a small proportion of cases usually considered hopeless; yet only a small percentage of cases can be cured after the disease has metastasized, because it is impossible to remove all the lymph nodes which may be involved. Schauta has recently shown that the higher lymph nodes may be involved without change in the lower ones, and if the lower ones are involved, the higher are also apt to be cancerous. Wertheim states that there has been recurrence in all of his cases in which the lymph nodes were involved at time of operation, and he now considers the removal of lymph nodes of prognostic value only, which opinion is shared by Clark. Sampson studied the abdominal and pelvic lymphatics in three cases which died after operation for the cure of cervical carcinoma. *Although these cases had presented extensive local growth, the pelvic and abdominal lymphatics were found free from cancer in two.*

The third case, however, was found to have involvement of a gland situated above the bifurcation of the aorta, thus demonstrating that the case was operatively incurable.

Should, therefore, attempt be made to remove the pelvic lymph-glands, if they appear to be involved at time of operation? Sampson, who formerly has been one of the strongest advocates of radical abdominal operation with the eradication of all glands, has modified his views as a result of recent observations. He now summarizes as follows: "We must conclude that the percentage of cases which we can cure by removal of the pelvic lymph-glands is small: so small that it may be more than offset by the increased primary mortality which must occur from the prolonged operation necessary for their removal." "I believe, however, that if at the close of the local operation the patient is in good condition, that the removal of the easily accessible iliac lymph nodes is indicated, for it is of prognostic value, anyway, and is undoubtedly of some curative value in a small percentage of cases." "These are the lymph nodes most frequently involved in the early extension of the disease." Sampson is a strong believer in the more radical operation. He insists that it must be borne in mind that it should be the object of the surgeon to cure as large a percentage as possible of all cases coming under his care. "By employing the more radical operation and operating all cases where there is a chance for a cure, we may hope to cure a larger percentage of all cases seen, although the growth may return in many of the cases operated." With experience and the development of a technic, the primary mortality should be but little greater than the less radical abdominal operation, while the percentage of cures will undoubtedly be higher. Thus Wertheim, in his latest report, states that of 31 cases operated upon by him three years ago or longer, 19 are at present free from cancer, thus giving a percentage of cures of 22.5 per cent of all the cases seen by him at that time, as compared with similar results in this country, of 5 to 8 per cent, or even less.

In proof of his assertion that cancer of the cervix is curable, the author quotes statistics from the gynecological department of the Johns Hopkins Hospital: "At the close of the first fifteen years of the department, 16 women, or 24 per cent of the operative cases heard from, and 19 per cent of all cases operated upon, were living and well, five years and longer after hysterectomy for carcinoma of the cervix. Four of these cases had survived ten years since operation."—*Albany Med. Annals*, vol. xxvi, No. 5, May, 1905.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF OBSTETRICS

UNDER THE CHARGE OF

C. S. Bacon, M. D. Rudolph W. Holmes, M. D.

C. v. Bachellé, M. D.

Ectopic Pregnancy. By O. V. Franque and A. Garkisch.

O. V. Franque and A. Garkisch report a case of extrauterine pregnancy which was operated on at the time of rupture. Serial sections were made of the whole tube, and these showed that there were two passages in the tube,— one leading from the uterus outward and ending in a blind sac, and the other parallel but separate from the first, and leading from the tubal ostium toward the uterus, and also ending in a blind sac. A minute opening connected the two canals at a point between the outer and middle third of the tube. They cite other cases in which similar development of the tube has led to this condition.

A second case showed a considerable narrowing of the lumen of the tube, besides containing large folds near the uterine end. The conclusions drawn were:

1. That congenital or acquired diverticula are a cause of extrauterine pregnancy.

2. That interstitial pregnancy is possible without the existence of a diverticulum or salpingitis nodosa; the cause being a narrowing of the tube lumen, or development of folds in the uterine end of the tube.

3. That decidual reaction is proved to exist in the intermuscular connective tissue in a tubal pregnancy, and also that a true decidua basilaris and capsularis develop in such cases.— *Zeitschrift für Heilkunde*, vol. xxvi, No. 9.

Repeated Extrauterine Pregnancy in the Same Tube. By P. Michin.

Cases of extrauterine pregnancy are so common nowadays that they no longer excite as much interest as formerly, and surgeons or gynecologists are practically unanimous as to the method of dealing with them. The method which is considered most ideal and most favored is that by which it is possible to remove the whole tube; however, there are still a few operators who prefer to open and clear out the pregnant tube through the vagina.

The latter method Michin believes ought to be rejected, for two reasons; namely, that if the gestation-sac is allowed to remain in the pelvis, it may give rise to any one of a number of inflammatory processes, and one cannot be certain that the condition will not recur, as it did in the case cited below.

The patient, aged 32, had been married eight years and had never given birth. She had had repeated attacks of oophoritis. Two years ago she was operated for a ruptured left tubal pregnancy. The operation was done through the posterior vaginal vault, the gestation-sac being opened and evacuated. From this she promptly recovered. Thereafter the menses were regular, but very profuse and painful. Two months after the last menstruation she began to have pain in the pelvic region, and fainted. This was followed by bleeding from the genitals. After that the pains continued, and were especially severe in the left inguinal region.

Examination showed a very anemic person, very faint, and complaining of headache; no appetite; the abdomen enlarged and tender in the lower portion; the urine, though normal, passed with difficulty; colostrum in the breasts; the portio vaginalis of doughy consistency; corpus uteri enlarged, to the left of which was a soft tender tumor, size of a fist and somewhat oval in shape; in the left vaginal vault a pulsating blood-vessel; to the right of the uterus a cystic, degenerated ovary.

The operation confirmed the diagnosis, and the specimen removed showed two embryos in the ruptured gestation-sac. An old clot marked the site of the previous pregnancy.

His conclusion is, that this should prove the possibility of recurrence of extrauterine pregnancy if the tube is allowed to remain, and hence the radical operation should be done in every such case.— *Monatsschrift für Geb. u. Gyn.*, vol. xxii, No. 4.

PULMONARY TUBERCULOSIS AS AN OBSTETRICAL COMPLICATION. By C. S. Bacon.

Bacon states that tuberculosis probably exists in 1 to 1.5 per cent of all pregnant women in such a degree as to be demonstrable. This is the same ratio that exists in all adults. He believes there is little reason why the ratio should be less in pregnancy, since tuberculosis only rarely causes sterility.

Much difference of opinion has existed as regards the effect of pregnancy on the disease. Formerly, it was thought to benefit the tubercular condition, or even cure it, but this was due, no doubt, to the improved general condition, to better hygiene, to more rest, etc. It is further possible that chemical changes in the blood, due to fetal products, may interfere with the growth of the bacteria. Frequently, however, pregnancy has a bad effect on the tubercular condition; rapid development in the lungs or an acute miliary fever appearing. This is especially the case when the disease is advanced or when nutrition is low. Nausea or vomiting, or other toxemias, add to the peril. In the latter part of pregnancy, pressure against the diaphram may interfere with the already imperfect respiratory function.

Labor sometimes leads to an immediate fatal termination in the more severe forms of the disease, and during the puerperium rapid progress of the tubercular process is seen. The puerperium, with its usually enforced confinement in poorly ventilated and overheated rooms, is injurious, and, as a result, thisi s a critical period for milder cases and a dangerous one for advanced cases.

The effect of tuberculosis on pregnancy is slight, except when there is considerable fever and coughing, when abortion is common. Placental or decidual hemorrhages are less common than in cardiopathies or nephropathies. Even when there is considerable emaciation the fetus suffers little.

The fetus rarely becomes infected, and then probably because of a solution of continuity of the placental partitions between maternal and fetal circulations.

In mild forms of the disease, labor may be quite normal, but in emaciated patients the contractions may be feeble and inefficient, and this, with weakness of the woman, is an indication for early interference.

The puerperium usually shows the effects of tuberculosis most markedly. If the exhaustion of labor is considerable, the patient may die in the first two or three days following; in milder cases she may become very much worse.

If tuberculosis undoubtedly exists, the woman should not marry, since that can only result in dangerous complications. As a rule, there should be no pregnancy in the tuberculous wife, but if the woman is extremely desirous for children, and can be put in the best hygienic surroundings during pregnancy and in the puerperium, and is fully cognizant of the risk, the physician may rightfully undertake to care for her. Where she must do her housework, and so stay indoors a great deal, and where the conditions are not ideal, conception should be forbidden. For such cases, Bacon believes artificial sterlization may be legitimate, but before this is done he probability of a cure should be carefully weighed. Vaginal or abdominal resection of the tubes is recommended.

If a tuberculous woman be pregnant, the decision as to whether or not the pregnancy should be interrupted will depend on the circumstances of the patient, whether she can be cared for as indicated above or not. A complication, as heart disease, nephritis, hyperemesis, or other serious acute or chronic diseases, is an additional indication for abortion. The operation should be performed before the twentieth week; later, the attempt should be made to carry the child on to the period of viability. As to method, the rapid emptying of the uterus is best. Careful anesthesia with ether is not contraindicated.

If pregnancy is allowed to continue, — 1. The patient should live in the open air as much as possible; 2. She should be fed with good, nutritious food; 3. She should avoid exhaustion or fatigue. Symptomatic remedies should be used. When viability is reached, unless alarming symptoms, as rapid failure of nutrition due to stomach disturbances, hemoptysis, exhaustion, uncontrollable cough, laryngeal or pleural or other respiratory complications, as dyspnœa, indicate prompt delivery, the operation should bepostponed until the thirty-sixth week.

The method should be that which furnishes quick relief from the urgent symptoms, and which also assists and hastens labor. For this reason the bougie method should not be used. Dilate cervix manually or with instruments, rupture membranes, and after the escape of the liquor amnii relieving the pressure symptoms a metreurynter should be introduced. In most urgent cases, vaginal Cæsarean section may be done.

The proper management of labor in a tuberculous patient involves careful watching, and

timely interference if exhaustion appears; oxygen, strychnin, and subcutaneous injections of salt solution may be needed. Postpartum hemorrhage is not particularly common in such patients. In the first forty-eight hours of the puerperium, the greatest danger lies in circulatory disturbances. Later, good nutrition and fresh air should be provided. Under no circumstances should the mother nurse the child. A wet-nurse is best, and there is no danger of the child infecting her.—*Jour. Amer. Med. Ass'n*, vol. xlv, No. 15.

TRANSPOSITION OF PARTS OF THE BODY BY AMNIOTIC BANDS. By F. Ahlfeld.

The discussion does not include the transposition of whole organs, as shown in cyclops formation, or in the large hernias of brain substance or abdominal organs, but takes up the less frequent forms of malformation, as when a whole limb is ligated off by an amniotic band and then transplanted upon another part of the fetal body or its appendages.

Martin's case, published in 1850, showed that it is possible for the upper arm to be gradually tied off by such bands, and the severed member to be born with the child, who showed a fresh amputation wound.

It is possible that before the amputation was complete, while the peripheral portion was still obtaining nourishment through the vessels in the pedicle, the part may be drawn by the band or adhesion to another portion of the fetal body or membranes, where it may continue to develop until the vessels of its pedicle are either torn or obliterated. That this sometimes actually occurs is shown in a case reported by Zagorsky, in which the amputated right foot hung from a band passing from the site of the amputation to the left foot.

If the ligated part lies in close proximity to another portion of the body, as it does in early embryonal life, and is held there by the amniotic band or adhesion which finally amputates it, it may adhere to the other part, and the stump, continuing to grow, soon changes its position with reference to the amputated part, so that the latter may be found attached far from its normal place. Such a case Ahlfeld presents, in which the foot was found attached to the buttock. Other cases have been described where the severed part was found attached to the placenta.— *Monatsschrift für Geb. u. Gyn.*, vol. xxii, No. 2.

VAGINAL OVARIOTOMY, INTRAPARTUM. By F. Geisthövel.

Geisthovel reports a case of dermoid cyst as an obstacle to labor in a 28-year-old primipara. On internal examination, he found the cervix effaced. head within the pelvis, and a firm, elastic, round tumor projecting into the vaginal canal, pushing the vaginal wall before it. It was found to be immovable. Under anesthesia, an unsuccessful attempt was made to replace the prolapsed mass, then a longitudinal incision was made in the posterior vaginal wall, and the tumor, after incision and evacuation of 150 c.c. of thick, semi-fluid material, was drawn out through the incision, its pedicle ligated, cut, and then allowed to slip back into the pelvic cavity. After that the head descended farther into the pelvis, but the pains, decreasing in strength, led him to terminate labor with forceps. The incision in the vaginal wall was not sutured, and no douches were employed during the convalescence, which was uneventful and without temperature.

The tumor was about 14½ cm. in length, 7½ cm. in breadth, and 5 cm. thick, and weighed about 500 grams.

Two other such cases are on record, and he believes, therefore, that, under certain circumstances, particularly in cases of large incarcerated ovarian or dermoid cysts, the operation is indicated, and furthermore, that it may be safely carried out, even under such unfavorable conditions.—*Monatsschrift für Geb. u. Gyn.*, vol, xxii, No. 2.

INFECTION OF THE LIQUOR AMNII. By Hellendall.

In considering the question as to the mode of entrance of bacteria in infection of the liquor amnii, Hellendall says that, theoretically, there are three possibilities:

1. Infection through the vagina, membranes being intact or ruptured.
2. Infection from the peritoneal cavity through the tubes and through the membranes.
3. Infection from the uterine wall.

It is generally acknowledged that after the rupture of the membranes the liquor amnii may become infected. Whether or not this is possible in the case of intact membranes had not yet been definitely proved. Clinically, it may be demonstrated either by the discharge of foul-smelling fluid when the membranes rupture, or by finding the bacteria in fluid aspirated from within the intact membranes. The former condition has been reported several times; the latter procedure, affording more exact evidence, had not yet been carried out. In order to throw some light on the question, he made seven experiments, using pregnant rabbits. Virulent bacteria — he found bacillus coli best — were introduced into the vagina, which was then either sewed shut or tamponed, and after 12–24 hours

laparotomy and complete hysterectomy performed. The intact membranes were cauterized with the actual cautery from above downward, then opened, and the liquor amnii examined bacteriologically. The uterus was sectioned. The results were as follows:

1. Either the whole ovum contained bacteria, or they were found only at the vaginal pole.

2. The musculature of the uterus was not invaded by bacteria, and they were found only in the inner layers of the decidual lining of the uterine mucous membrane, from the vagina upward to the tube.

This leads to the conclusion that virulent motile bacteria introduced into the vagina may spread upward between the oval membranes and the uterine wall, and may also entera nd infect the liquor amnii.

Whether or not it is possible for such infection to pass downward from the peritoneal cavity, is not yet proved. This has a bearing on cases of peritonitis or appendicitis in pregnancy, for it has frequently been observed that the children are born dead, or die soon after birth, with septic symptoms; the mortality of the children being 85 per cent. Those who have discussed the question are not agreed as to whether the infection comes from the abdominal cavity, the uterus, or through the blood. This Hellendall attempted to clear up by another series of experiments. In this case, intraperitoneal infection of pregnant rabbits was made with the following results:

1. The egg-contents showed bacteria, and these were especially abundant near the peritoneal openings; less abundant toward the vagina.

2. The connective tissue between the fetal membranes contained many bacteria.

3. The uterine section showed no bacteria, except in the serous and mucous membranes.

Therefore he believes that infection may thus pass down the tubes to the egg, and, penetrating the membranes, contaminate the liquor amnii.

That hematogenic infection of the egg may occur he has also demonstrated by intravenous infection of pregnant animals, with the following results:

1. In all cases a large number of germs were found in the ovum.

2. These were demonstrable within three hours after their introduction into the blood.

3. The blood-vessels of the placenta, and especially the egg-membranes, were filled with bacteria.— *Zentralblatt für Gynäkologie*, No. 41, 1905.

HEMORRHAGE IN TUBAL PREGNANCY DUE TO THE CORRODING PROCESS OF THE OVUM. By J. Riddle Goffe.

Goffe remarks that in many cases of hemorrhage in extrauterine pregnancy, the most careful microscopic examination of the tissues removed has failed to show any trace of the product of conception or the source of the bleeding. Minot has shown that in the process of implantation the ectoderm of the chorion undergoes a peculiar proliferation, by which its cells become very much more numerous. Some of the cells rapidly assume a distinctive character, and are easily recognized by their large size. This layer of ectodermic cells is called by Minot the trophoderm. Wherever these modified ectodermic cells come in contact with the walls of the uterus, destructive changes go on in the uterine tissue, producing a cavity in which the ovum lodges itself. The trophoderm then undergoes a hypertrophic degeneration, producing a series of irregular spaces which persist and become the intervillous spaces of the placenta. Papillary outgrowths of the chorionic mesoderm meanwhile penetrate the trophoderm, initiating the formation of the chorionic villi.

The effect of this corrosive action, when it occurs in the thin-walled tube instead of in the uterus, may be easily imagined. In most cases the implantation is successfully accomplished, but in others the corrosive action continues completely through the tube-wall, or may bring the intervillous spaces so near the surface that the blood-pressure bursts the peritoneum and gives rise to serious hemorrhages.

A case is cited in which this condition occurred. The symptoms and history pointed to extrauterine pregnancy, and as the patient went into collapse after examination, she was operated. On opening the peritoneum through the vagina, old and new clots and liquid blood burst out. The tube was enlarged, thickened, congested, and appeared to be intact, but upon examining the posterior surface at the middle third, a small pinhole opening with protruding blood-clot was seen. The tube was then removed and the cul-de-sac drained.

On examination of the removed tissue, no indication of development of a placenta or of chorionic villi could be found. Therefore the ovum, at a very early stage, must have eroded its way through the tube, and hemorrhages must have been quite frequent, if not almost continuous.

He believes that it would be a fair inference that when a woman has skipped one menstrual period, and is attacked by sharp pain in the hypogastrium, collapse, and vomiting, with markedly weak pulse, if there be no temperature, an erosion through the walls of the gravid tube should be suspected, and the necessity of prompt operation seriously contemplated.— *Jour. Amer. Med. Ass'n*, vol. xlv, No. 19.

REVIEWS

A TEXT-BOOK ON OBSTETRICS. By Adam A. Wright, B. A., M. D., Professor of Obstetrics, University of Toronto. Illustrated 8vo, cloth, $4.50. New York: D. Appleton & Co.

In the flood of obstetrical text-books which has been poured out during the last five years, it is difficult to see that more than two or three have any real reason for publication.

Aside from the desire of a writer to see himself between boards, there is always temptation on the part of the publisher, and the certain knowledge that nothing is easier than the development of the ordinary text-book. Made up of heterogeneous abstracts from the accessible literature, the compilation usually presents a large amount of trite and elementary truth, together with a generous quantity of unproved and probably undemonstrable theory, which has been passed on from book to book, without revision or question, in endless repetition, because the writer finds nothing in his own experience nor in the literature to present in its place.

As a result, the book represents no originality, except the order in which the various subjects are arranged. It is quite a relief, therefore, to look over the work of Dr. Adam H. Wright, of the University of Toronto, which has just appeared from the Appleton press, and shows on every page the strong individuality of the author.

This book represents the actual practice (he spells it *practise*) and experience of a well-equipped and enthusiastic obstetrician, who has tried all things, and has held fast to that which he found good. He has presented the result in a coherent and palatable way that is far more attractive than usual.

In fulfilling the requirements of a text-book, the publishers have considered and secured lightness and ease of handling. The paper does not offend by its gloss or odor, and yet does full justice to the abundant illustrations. Among the latter, it is distinctly refreshing to the eye to see pictures of Pasteur, Lister, Holmes, Sommelweiss, and others who have stamped their personalities and achievements upon the obstetrical and medical world. The value and pleasure of these pictures to the student can hardly be overestimated.

One exception must be made to the general excellence of the illustrations. The plate entitled "Walcher's position" must be a misnomer; it is certainly incorrect, and in no way represents that position; furthermore, there seems to be no adequate description of this important maneuver in the text of the work.

In the description of the implantation of the ovum, on page 18, the author has attached practically no importance to the revelations of Peter's ovum. The pathology of pregnant labor and puerparium is well covered in a practical way; in fact, the author, throughout the work, has emphasized clinical and practical methods, together with the results of his own valuable experience, which he supplements by the insertion of numerous interesting and instructive cases. The conduct of normal labor is complete and satisfactory.

The statement that no prominent obstetrician in Great Britain or America approves of episiotomy is rather surprising, but not far from correct.

The book, as a whole, is delightfully free from the tedious and uninstructive discussion concerning things we do not know, and is complete and satisfactory in regard to what we do know, but its main recommendation is the strong, virile flavor of Dr. Wright which prevades its pages.

C. B. REED, M. D.

POST-OPERATIVE TREATMENT. By Nathan Clarke Morse, A. B., M. D., Eldora, Iowa. Containing 5 plates and 155 other illustrations. Philadelphia: P. Blakiston's Son & Co. 1905.

In many of the late works on surgery and operative gynecology little space is devoted to the details of the preparation of the patient for an operation and the post-operative treatment.

This work fully covers this essential department in operative work. The author, in the preface, states specifically that he has intentionally omitted all discussion of surgical pathology and bacteriology confining himself strictly to the subject of preparation and after-treatment of the patient. The work is intended for the students of surgery who may have had the opportunity of witnessing many operations, but who have had little training in the preparation and after-care of the patient.

The work comprises, in the main, detailed descriptions of the technic of many of the prominent surgeons of America and England.

Chapter 1 is devoted to general remarks on the preparation of the patient, including preparation of the field of operation.

Chapter 2 deals with the post-operative wound suture, dressing and draining, and is illustrated by

several plates showing the closure of median abdominal incisions.

In chapter 3 the writer discusses post-operative complications, including under the subject hemorrhage, sepsis, lung complications, gangrene, and post-operative delirium and insanity.

Chapter 4 recites the author's method of the after-treatment of the patient following a surgical operation.

Considerable space is devoted to the consideration of the subject of treatment of shock.

In some of the succeeding chapters the more important surgical operations are taken up, and the post-operative treatment given in detail in connection with each individual operation. Frequent reference is made to the authors of the various methods of technic employed in the after-care.

Short chapters are devoted to the various splints and appliances used in the treatment of fractures and in the retention of limbs following the excision of joints, together with a review of many of the more common orthopedic devices.

In chapter 19 there are a few general considerations of the value of the Roentgen ray in post-operative treatment.

The work, as a whole, is a fine example of the publisher's art, the paper, type, and binding being excellent. It should have a place in the library of the student of surgery whose hospital training has been limited, and who is anxious to give his patients the advantage of the experience of the men who have had unlimited advantages in this department of surgery.

PRACTICAL MASSAGE IN TWENTY LESSONS. By Hartwig Nissen, Instructor and Lecturer in Massage and Gymnastics at Harvard University Medical Summer School. Philadelphia: F. A. Davis Co.

This little treatise of one hundred and sixty pages is just what it purports to be. The first hundred pages deals with the general details of massage, while the latter third discusses its use in the various conditions in which it may be found helpful. Naturally, since it comes from the pen of one who is not a physician, but has had an extensive experience in his profession, the first part appeals more to the physician than the latter. However, even here the detailed prescriptions for various diseases will be found suggestive to the scientific practitioner.

BOOKS RECEIVED

Lehrbuch der Vibrationsmassage mit besonderer Berucksichtigung der Gynaekologie. By Dr. Kurt Witthauer. Oberarzt an diakonissenhaus zu Halle, A. S. Mit 18 Abbildungen. Price 4 marks. Leipzig: F. C. W. Vogel.

CORRESPONDENCE

EDITOR SURGERY, GYNECOLOGY AND OBSTETRICS: I would consider it a great favor if the American surgeons would send me a short note on the number of gastroenterostomies performed for benign lesions of the stomach, and whether, in their experience, they have observed any cases of secondary peptic ulcer of the jejunum.

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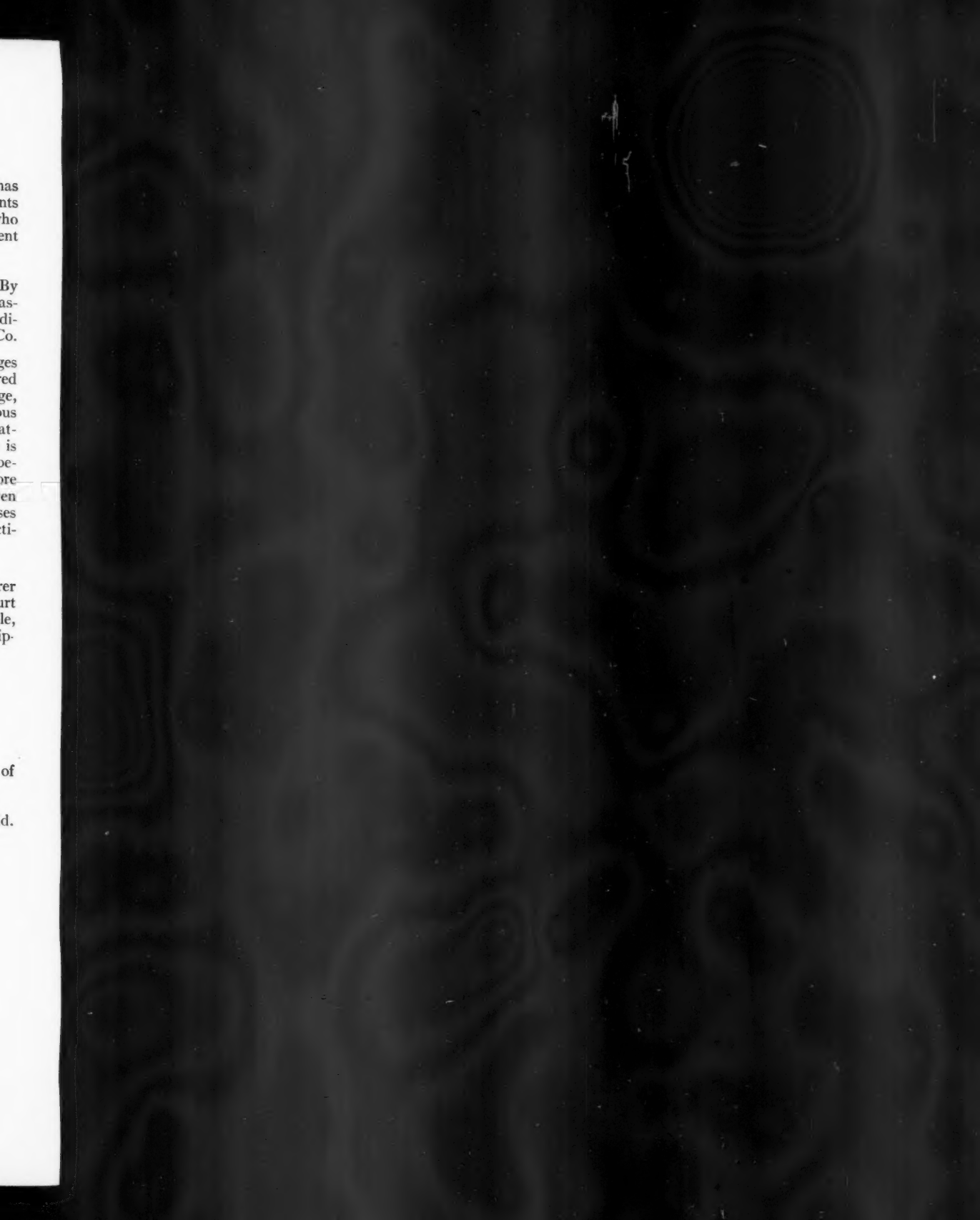

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FRANKLIN H. MARTIN, M. D.

Managing Editor

103 State Street, CHICAGO, ILL.

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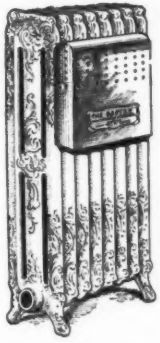

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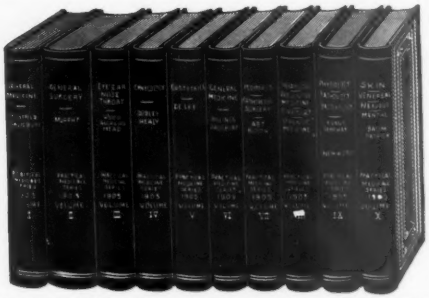

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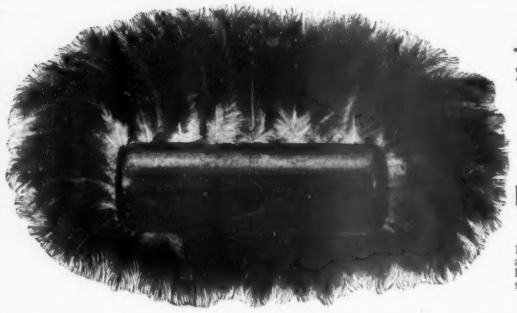

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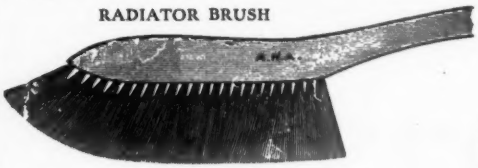

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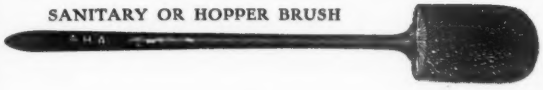

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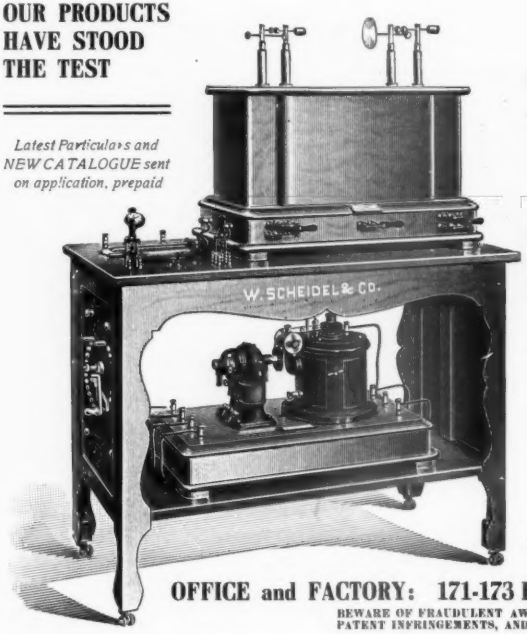

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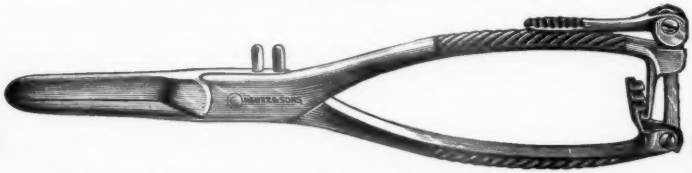

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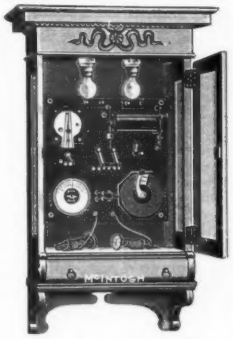

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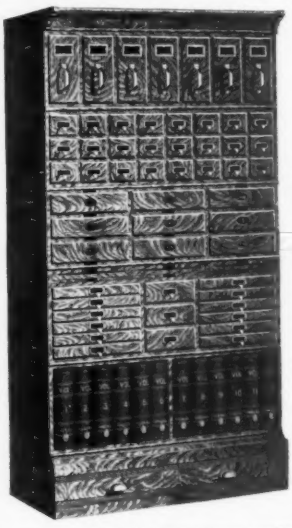

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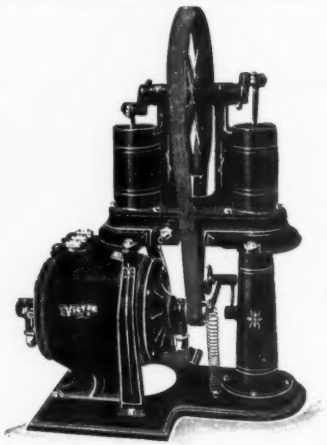

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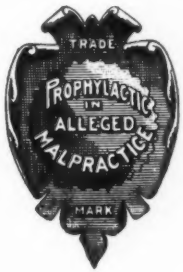

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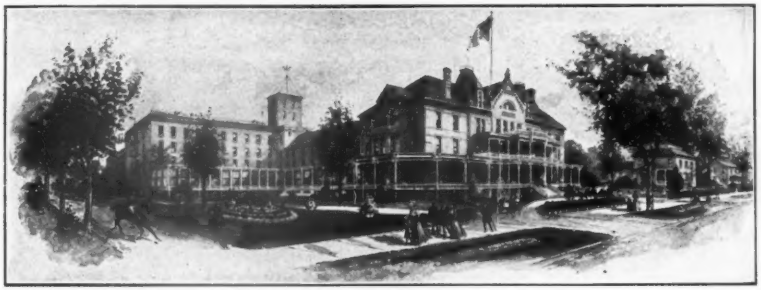

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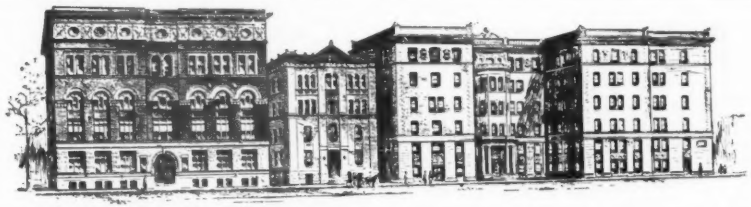

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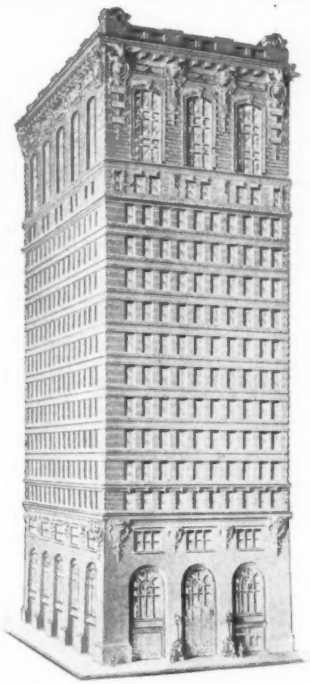

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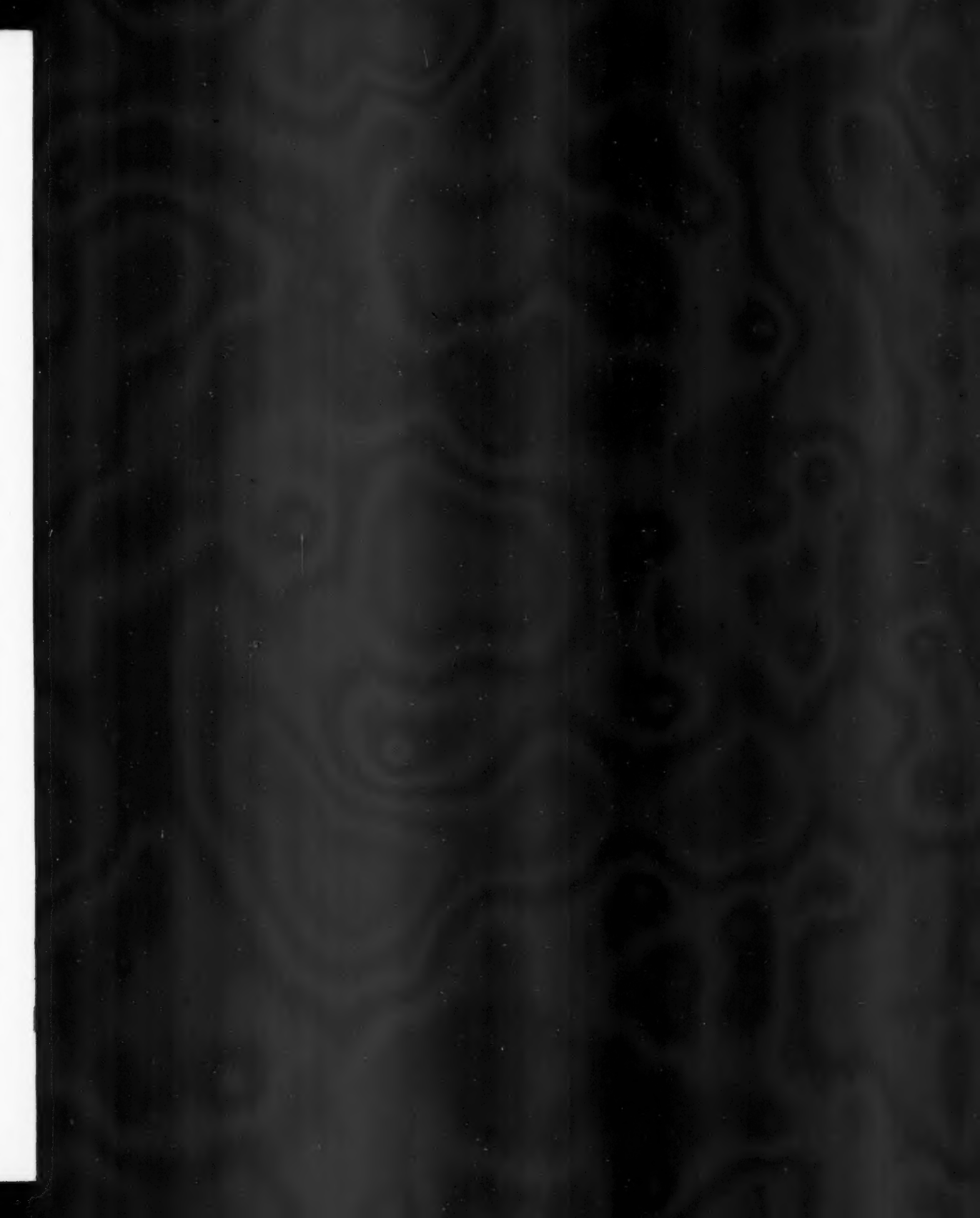
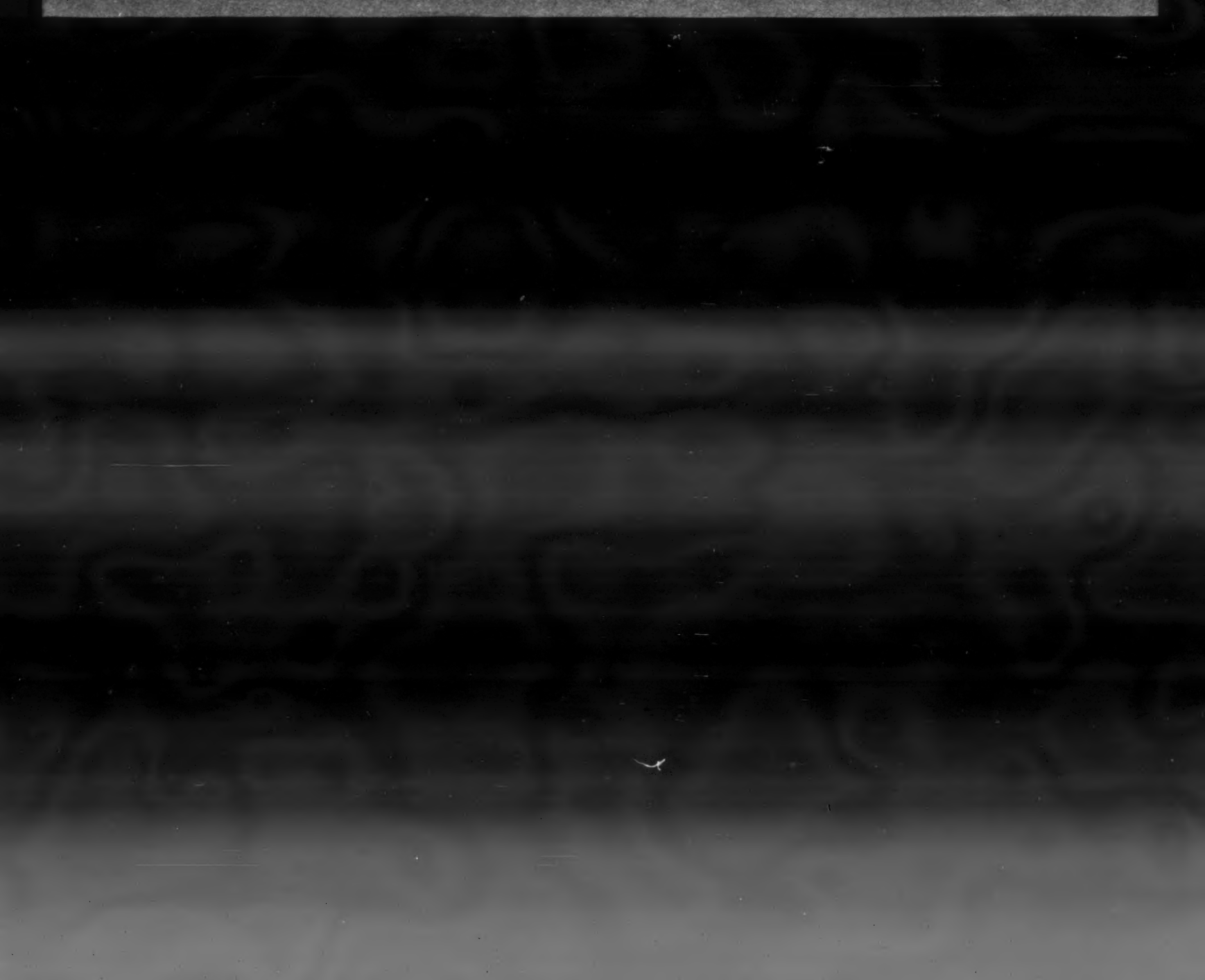
Alexis Carrel, M. D., Chicago.

Experiments in the Healing of Wounds of the Ureters,
W. R. Cubbins, M. D. Chicago.





A Sparkling Laxative Table Water

Hydrox-Lax SPLITS

PURE and PLEASANT

FORMULA

Sodium Phosphate 21.56 gms. Sodium Chloride 0.33 gms.
Sodium Sulphate 0.63 " Sodium Carbonate 0.13 "
Hydrox double-distilled water 240 c. c. highly aerated.

Owing to its perfect purity and pleasant invigorating taste it is peculiarly adapted to the cases of persons afflicted with delicate stomachs, as it does not produce the slightest nausea. A glassful on arising acts as a gentle aperient.

Hydrox GINGER ALE

All the best hospitals keep it constantly on hand and it is used as a grateful thirst quenching drink and mild stimulant for the convalescent.

Hydrox VICHY

AFTER GRANDE GRILLE

Preferred to the imported by many eminent physicians because of its constant uniformity and purity, and the absence of that stale taste so commonly found in the imported bottled waters. The greatest care is exercised in all branches of the manufacture of the products of The Consumers Company, whether it be the purification of the water Hydrox, the carbonic acid gas, or the compounding of the various mineral waters, beverages, etc., and all details have the constant attention of competent chemists.

Hydrox

ABSOLUTELY and INVARIABLY PURE

Hydrox Lithia (Still or Carbonated)	*Hydrox Seltzers*	*Hydrox Club Soda*	*Hydrox Sarsaparilla*
Hydrox Kissengen	*Hydrox Carlsbad*	*Hydrox Ginger Ale*	*Hydrox Birch Beer*
	Hydrolaris	*Hydrox Root Beer*	

THE CONSUMERS COMPANY

35th and Butler Streets, Chicago

The sick man's ability to appropriate the foods given him must be reckoned with, especially in all cases where the blood is thin and the vitality low

Extract of Red Bone Marrow

Medullary Glyceride

is easily assimilated, and has in it the elements that are needed by those afflicted with anemia, chlorosis, marasmus, rachitis, malaria and other diseases that the physicians meet with daily.

Sig.—1 to 2 dr. well diluted with cold water t.i.d.

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